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Overview of the Super Database Computer (SDC-1)

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[Text]

Summary

This paper presents an overview of the SDC-I (Super Database Computer I) developed at the University of Tokyo, Japan. The purpose of the project is to build a high performance SQL server which emphasizes query processing over transaction processing. Recently relational database systems tend to be used for heavy decision support queries, which include many joint, aggregation, and order-by operations. At present high-end mainframes are used for these applications which, in some cases, require several hours. While the system architecture for high traffic transaction processing systems is well established, adhoc query processing has not yet adequately understood. SDC-I proved that a parallel machine could attain significant performance improvements over a conventional sequential machine through the exploitation of the high degree of parallelism present in relational query processing. A unique bucket spreading parallel hash join algorithm is employed in SDC, which makes the system very robust in the presense of data skew and allows SDC to attain almost linear performance scalability. SDC adopts a hybrid parallel architecture, where globally it is a shared nothing architecture, that is, modules are connected through the multistage network, but each module itself is a symmetric multiprocessor system. Although most of the hardware elements use commodity microprocessors for improved performance to cost, only the interconnection network incorporates the special function to support our parallel relational algorithm. Data movement over the memory and the network, rather than computation, is heavy for I/O intensive database processing. A dedicated software system was carefully designed for efficient data movement. The implemented prototype consists of two modules. Its hardware and software organization is described. The performance monitoring tool was developed to visualize the system activities, which showed that SDC-I works very efficiently.

1. Introduction

The database management system is one of the most important components of the modern computer systems. Recent widespread adoption of relational database systems, mainly due to its ease of use, has led to the creation of larger and larger databases, which has brought about the great demand for super relational database servers that have much higher performance than current ones. One of the key features of relational database systems is their employment of the non-procedural query language, SQL, through which users can issue adhoc queries very easily. This stimulates the use of the relational database for query processing, while traditional database management systems have been mainly adopted in high traffic transaction processing systems.

Commercial database applications can be classified roughly into two types: transaction processing (TP) and query processing (QP). Considerable research has been done on TP. Large online systems such as banking with ATMs, reservation systems, and stock marketing systems have been constructed. This technology, which is characterized by very high traffic rate and relatively small access to the database, has already matured. Relational database systems now tend to be used for query processing applications such as decision support, market analysis, sales trend analysis, and information mining. Since queries are issued to the system in an adhoc way, they usually access the attributes which are not indexed. Query processing for statistical analysis scans very large amounts of data and takes a very long time to complete. It can take several hours, even days in certain cases. Large amounts of data generated by transaction processing is accumulated and this data tends to be used by query processing for statistical analysis. The standardization of the benchmarks reflects the prevalence of such applications. TPC-A, B, C are well known benchmarks for transaction processing, and, at present, frequently used as performance metrics of the machine. Currently, TPC is working to establish yet another benchmark called TPC-D, which is targeted for decision support queries.

Much more powerful machines are required to support query processing, since it has to scan a very large amount of data and has to do some computation over it. Current mainframe machines are not necessarily sufficient. There are two directions that can be taken to improve the performance of relational database processing: the special purpose processor approach and the parallel processor approach. Searching is one of the most fundamental operations. Special hardware to accelerate the search operation has been researched [3], [7], [19], [22] and developed as a product [9], [18], [23] which performs interpretation of the physical record structure, predicate evaluation and the efficient extraction of necessary fields from the records. If search processing is done by the CPU, all the data from the disk must be transferred to the CPU via the channel. The bandwidth of the channel is usually limited and is a very expensive resource. Intelligent disk controllers which incorporate the search logic are currently used in mainframe computers. It is reported that these devices can decrease the load of the channel dramatically and increase the system throughput [18]. This filter processor is very effective for the reduction of the data but is not so helpful for the heavy relational operators such as join.

The other key function frequently used in database processing is sorting. Most of the current commercial products use a sort library as a preprocessor for the relational operations such as join, aggregation and duplicate elimination. Sorting is also heavily used for report generation and index creation. Due to the heavy load caused by sorting, special hardware engines have been developed. IDP (Integrated Database Processor) [17] by Hitachi modifies the vector processing unit to support the merge operation. By using those vector units iteratively, it can produce a fully sorted record stream. Another special sort machine prepares log N comparators connected linearly with each dedicated memory bank [4], [20]. This can sort the record stream in $O(N)$ time, while the uniprocessor machines take $O(N \log N)$ time. Linear time sorting means that the file read-out from the disk can be directly fed into this sort accelerator. High speed sorting plays a very important role under practical applications. Since the late 1980s, large computer manufacturers, especially Japanese companies, have developed special database accelerators. Since considerable investment has gone into the development of host machines, application specific functionality should be designed to integrate with these systems with minimal impact. The sorter is added as an extension to the host system. A hardware sorter can boost the performance of join operations, but it is a basically sequential architecture and cannot exploit a high degree of parallelism.

Recently the computer industry has seen a shift from the use of proprietary systems to the use of open systems. Downsizing stimulates the replacement of the large mainframe-based centralized system with an inexpensive microprocessor-based distributed system using open software. For transaction processing applications a multiprocessor system fits very well and can attain very high transactions per second, which is much higher than mainframe machines. If such general purpose parallel processor systems based on inexpensive microprocessors can be used for relational query processing, we can realize very powerful as well as scalable systems. Parallel database processing has been an active research area for the last 10 years [1], [2], [5], [8], [15], [24].

So far we have done research on performance issues on relational database systems. We have developed the parallel relational algorithms, high speed hardware sorter and the functional disk system (FDS) [12], [13], [15], [16]. FDS was implemented to determine whether introducing database functionality into the disk controllers leads to improved database performance. Based on our previous results, we started the SDC project in 1988.

SDC-I is an experimental prototype to prove the viability of microprocessor-based parallel query processing servers [6], [10], [14]. One of the most unique features is in its use of the bucket spreading hash join algorithm which is robust against data skew. With this algorithm, SDC can achieve high degrees of scalability. Extra hardware was introduced into the interconnection network to assist the algorithm. A dedicated operating system was constructed to support efficient data transfers among the modules. These transfers are essential for data intensive database processing. SDC-I consists of several modules interconnected by the network, where each module contains five MC68020 microprocessors, while SDC-II under development employs seven MC68040's. The I/O system is much more enhanced compared with current scientific parallel machines. SDC-I was designed to have very powerful query processing capabilities. This paper overviews several aspects of SDC-I: its parallel relational algorithms in Section 2, its architecture in Section 3, its software system in Section 4, and its performance monitoring tools in Section 5. Section 6 presents our conclusion.

2. Parallel Relational Algorithm

In order for a parallel system to work effectively, the target application must have substantial inherent parallelism which is easily exploitable. Fortunately, relational query processing applications contain high degrees of parallelism. This parallelism can be categorized into three levels. Several queries can be processed in parallel (inter-query parallelism). Several operations within a query can be processed in parallel (intra-query parallelism). A single relational operator can exploit data parallelism (intra-operator parallelism). Thus large amounts of parallelism can be exploited for relational query processing.

Then we need an efficient parallel algorithm which can exploit this parallelism. Usually very sophisticated sequential algorithms tend to be difficult to be parallelized. SDC employs a new parallel algorithm named "Bucket Spreading Hash Join" [14]. Conventional parallel hash join algorithms are very sensitive to data skew, because the buckets generated by the hash function are assigned to the processors statically. Thus the size of the hash tables varies among the processors. In some cases, certain processors' memories may overflow and the others may not. If overflow occurs, performance deteriorates significantly. The total execution time is determined by the slowest module. Thus the conventional naive parallel hash join algorithm or the parallel hybrid hash join algorithm are very fragile under non-uniformly distributed data. Any parallel processing system must pay careful attention to load balancing in order to achieve linear scalability. The bucket spreading hash join algorithm is designed so that it works well even if the distribution of data is skewed appreciably.

The algorithm utilizes a shared nothing architecture and assumes that all the relations are fully declustered over the modules. The bucket spreading hybrid hash join algorithm works as follows. Let the smaller relation be R and the larger be S.

i) Build Phases: Each module applies the hash function to each tuple of its portion of the relation R, then sends out the tuples over the interconnection network, named bucket flattening omega network. This functional network automatically distributes the tuples with the same hash id equally among the modules. If the size of the relation R is small enough, the whole relation fits into

the main memory space. However, if the relation size exceeds the size of main memory, then the dynamic destaging mechanism is invoked [11], [21]. The largest bucket is selected and the tuples of that bucket are destaged into the disks. The memory space occupied by this bucket is released for use by incoming tuples. Every time the memory space becomes full, dynamic destaging occurs. When SDC finishes reading all the tuples from the disks, it examines the size of the buckets in memory. Since the bucket flattening omega network distributes each bucket evenly over the modules, a certain coordinator can schedule the bucket assignments with its local information. Each module exchanges the bucket fragments among each other following the given schedule and builds its own hash table. This scheduling and data exchange seems to be an extra cost, since such processing is not required by the naive parallel GRACE hash join. However, this contributes to the avoidance of hash table overflow and can utilize the memory space with the highest degree of efficiency. In addition, the time necessary for it is small, since data exchange involves not the disk I/O but only communication over the interconnection networks, where the recent network bandwidth is much higher than that of the disks.

ii) Probe Phase: The relation S is read out from the disk and the hash function is applied to each tuple. If the hashed value falls into one of R's bucket ids which are stored in the current module's main memory, that tuple is probed against the local hash table and the result tuples are produced. The result tuples are again hashed over the attribute for the next operation and sent out over the bucket flattening network. If the hashed values fall into R's bucket ids which are stored on the current module's disk, the tuple is stored back into the disk. Otherwise, the tuple is sent to the corresponding module according to its hashed value. When all the tuples are finished being read from the disks, the result tuples for the buckets resident in memory are produced and the nonresident buckets are stored back to the disks. At this time, the statistical information on the buckets stored on the disks are available for scheduling the remaining buckets. The assignment of buckets to the processors is determined with this information, this process is called bucket tuning [11]. Once the schedule is fixed, build and probe phases are repeatedly performed until all the tuples have been processed.

3. Architecture of SDC-I

3.1 Global Architecture

As shown in Fig. 1, SDC-I globally employs the distributed memory architecture where modules are connected through the interconnection networks. Each module itself is a symmetric multiprocessor system (SMP). Although the single processor per module approach is much simpler, we adopted SMP as a unit of the system. This relies on our belief that in the near future a single chip will include multiple processors to increase the performance beyond the degree of superscaler parallelism. Also, we believe that the system software will support both shared memory and message passing paradigms.

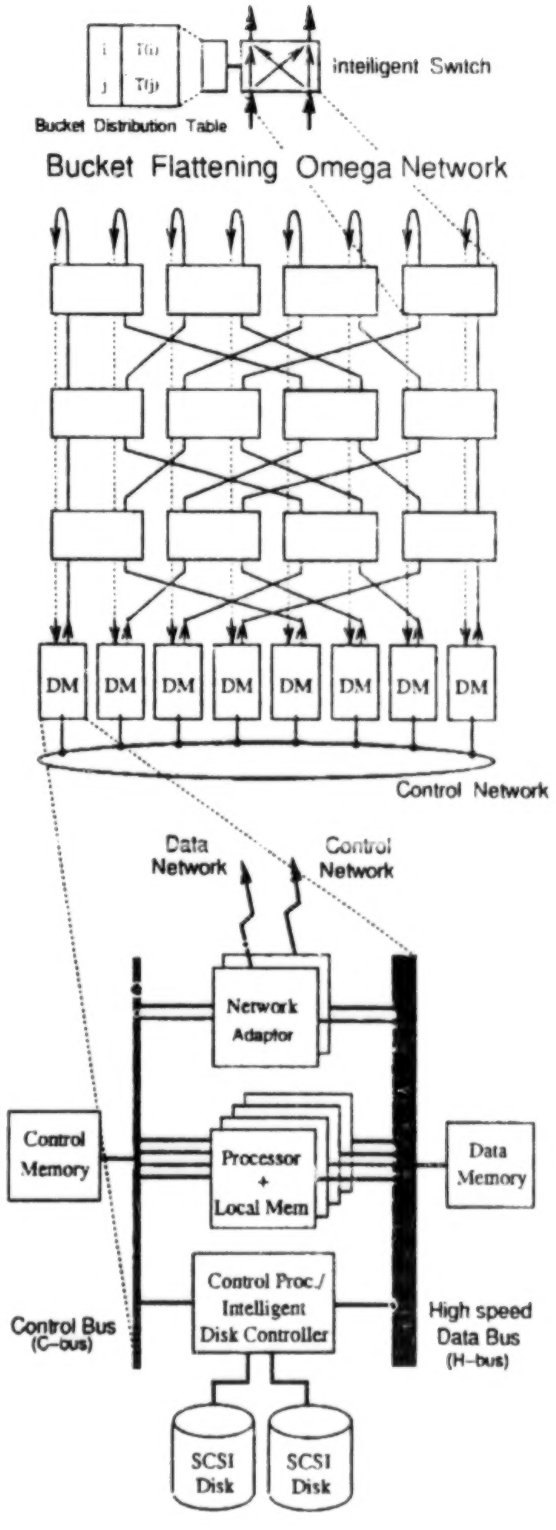


Figure 1. Overview of Super Database Computer I (SDC-I)

A single module contains four MC68020 microprocessors. Processors are connected through two buses, one for high speed data transfer (H-bus) and the other for handling control information and mutual exclusion (C-bus). The H-bus is used solely for bulk data transfer. Memory is also composed into two portions: an 8 Mb data memory for the raw tuple data and a 2 Mb control memory for storing the control data structures such as page address lists, hash table entries, and memory consumption statistics for each staging buffer. Each module controls two disk drives in parallel. The disk controller identifies the tuple boundaries, generates the logical page and invokes DMA transfers to the data memory. Two disk controllers are managed by the control processor (CP), which manipulates the page table on the control memory and sets the DMA information for the disk controller. The control processor also manages all the activities of the module, such as the synchronization of four processors.

Modules are connected through two kinds of interconnection networks: the data network and the control network. The data network offers high-speed channels for data transfers, while the control network handles control information and supports communications with front-end machines. Each module has a network adaptor for each network. When invoked by the control processor, the data network adaptor asynchronously begins the data transfer from the data memory to the data network through the FIFO buffer memory on the adaptor, while processors are producing the pages of the result tuples on the data memory. In the same way, the network adaptor handles receiving tuples from the network. Although Fig. 1 shows eight modules, two modules were actually implemented and evaluated.

3.2 Functional Interconnection Network

As described above, the interconnection networks of SDC-I are composed of the data network and the control network. The data network was designed to incorporate special hardware to support flat distribution of buckets, which is the key mechanism to handle the data skew. Since the switching units in the network offer the flattening function, processing modules need not care about the data distribution.

An omega network is employed as the network topology (Fig. 1). Each switch can be set to either of two states, straight or crossed. These switches are not controlled by the centralized control manager. They set their states autonomously using only local information.

To accomplish flat distribution of the buckets, each switch keeps the value, $D(X)$ in a counter for each bucket id, X, which is the difference between the number of tuples of the X-th bucket output to the left port and output to the right port. Since the number of counters in each switch equals to the number of buckets, counters are implemented with standard RAM chips and simple ALU logic. All counters are set to zero before the query begins. When a tuple of some bucket arrives at the switch and it is given to the left output port, the counter for that bucket is incremented. If it is given to the right output port, the counter is decremented. Thus $D(X)$ represents the skew of the bucket distribution. If $D(X) > 0$, more tuples have been switched to the left output port than the right port.

Let X_{left} and X_{right} denote the bucket ids of the tuples which arrived at the left and right input ports, respectively. Then $Dif = D(X_{left}) - D(X_{right})$ represents the relative skew of the distribution of tuples in the bucket of X_{left} and X_{right}. In order to distribute buckets as flatly as possible over the modules, the state of the switch is set to crossed if $Dif > 0$ and straight if $Dif < 0$. The state of the switch can be determined arbitrarily if $Dif = 0$. Figure 2 shows an example of switching behaviors. Here, the left input port receives a tuple from the m-th bucket and the right port a tuple from the n-th bucket. Since Dif is positive, the state of the switch is set to crossed.

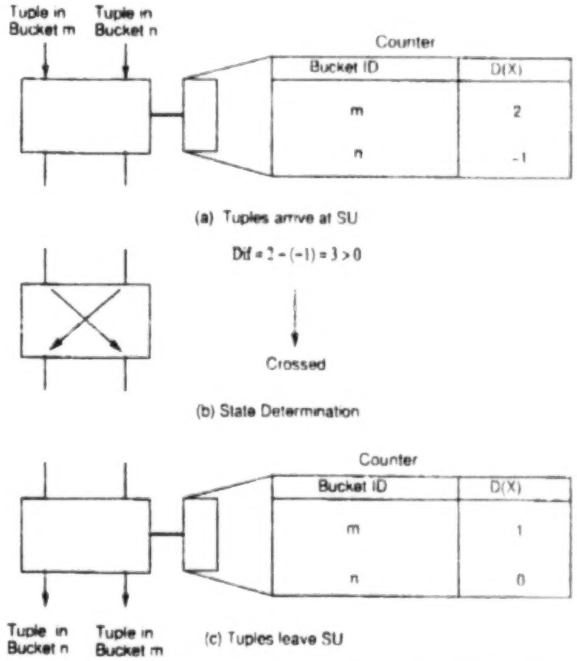


Figure 2. State Determination in a Switching Unit

If the tuple length is fixed and all tuples are given to the switches synchronously, this network achieves block-free transmission. Usually, SDC-I assumes a full declustering storage scheme, that is, all the relations are declustered over all the modules. The relational operators in a query are processed one by one in left-deep tree fashion or segment by segment in right-deep tree way, and block free interconnection can be fully utilized for the relations of fixed length tuples. However, in order to support variable length tuples or to support bushy tree execution parallelism, each switch has to handle asynchronous arrival of the tuples at the two input ports. The tuple which arrived earlier can determine its output port using

$D(X)$. But the tuple which comes later has no choice, when the transfer of the primary tuple is still in progress. To output this tuple to the remaining port might increase the skew. In such cases, the switch blocks the transmission. Thus, asynchronous switching incurs blocking, while synchronous switching has no blocking. We introduced a threshold value to decrease the blocking ratio at the cost of increased skew. That is, when there is a possibility of blocking, each switch tests $D(X)$ - Thr instead of just $D(X)$. Thr is, in fact, a function of the current state of the switch, taking the value T if the unused output port is the left port, and the value - T if it is the right one, where T is a positive constant number. A large T makes the value of the test expression increase or decrease according to whether the unused output port is the right or left one respectively, and causes blocking to be less likely to occur. Thus the value T is a relative penalty of blocking to data skew.

In SDC-II, we are planning to add two more extensions to the bucket flattening function to support more general environments. One extension is support for variable length tuples. The counter is incremented or decremented by the tuple length in bytes after the switch state was determined. As a consequence, all the modules can receive almost equal volume of tuples, rather than equal number of tuples. This avoids bucket overflow due to the skew in the data volume and eases the management of the memory space. The other is to allow the number of modules to be an arbitrary number (i.e. other than a power of 2). Usually, the number of the modules should exactly equal to a power of 2, because of the nature of the multi-stage network. However, such a restriction causes the inflexibility of system configuration. The user may want to construct the system with an arbitrary number of modules. For the system with n modules where $2^{k-1} < n \leq 2^k$, we use k stage omega network with 2^k - n ports disabled. We introduced another parameter representing the number of active ports, and use it as a weighting factor so that the unequal number (or volume) of tuples can be output from the right and the left ports. The details of the algorithms are beyond the scope of this paper, and will be described in the future paper.

4. System Software

The software system of SDC should be designed so that the bucket spreading hash algorithm can run as efficiently as possible. Parallel hash based relational database processing algorithms require that the tuples always flow through the modules. While the computation load is heavy for scientific applications, for database processing, data movement over the memory and the network is much more intensive than computation. Efficient data movement is the largest concern in I/O intensive parallel database processing. SDC adopts an I/O driven processing model. An abstract view of data movement in SDC-I is depicted in Figure 3, where dark circles denote tasks composed of a filled page and white circles those with an empty page. The tasks are generated by the disks and are put on the task pipe over the shared memory. The processors, represented by four rectangles at the center of the figure, fetch the task from the pipe, perform relational algebraic operations on it, produce result tuples and apply the hash function for the next operation if necessary, and finally release the page which was occupied by task to the free page pool. The tasks generated by the processors are sent out to the other modules over the network or written back to their own disks. The programmer writing the relational processing code does not have to be concerned with the details of flow control.

SDC Operating System (SDC-OS) which was developed as the fundamental system software for SDC-I provides only the following four primitives to the programmer:

getTask ( ): get a task from the input pipe

putFree ( ): return an empty page to the free pool

getFree ( ): get an empty page for result tuples from the free pool

putTask ( ): put a task into the output pipe

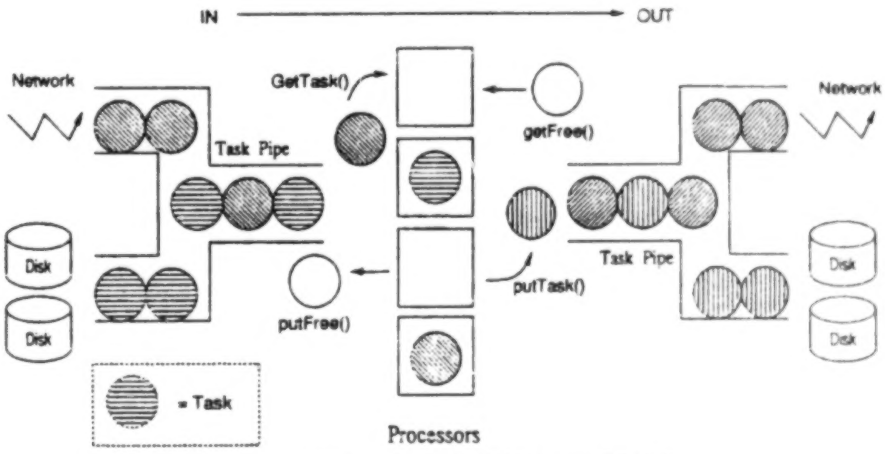


Figure 3. SDC-OS Process Model

Conventional operating systems suffer from the data copy overhead between the various layers of software, for example between kernel space and user space. SDC-OS was carefully designed to reduce this overhead as much as possible. The disk controller and network adaptor incorporate task generation hardware. The tuple stream from the disk/network is transformed into the page format by hardware, which is then placed on the task pipe. During the data transfer, there is no explicit copy operation. Only the pointers to the pages are exchanged among the processors, the disk controller, and the network adaptor via the control memory.

Flow control and buffer management are also important issues for parallel database processing which are handled by SDC-OS. There are four kinds of buffers: a read buffer for the disks and the networks, a net buffer, a write buffer, and a bucket buffer for the hash table. A high water mark is introduced on the net buffer. If the number of tuples in the net buffer exceeds the high water mark, the disks are suspended from reading the tuples, waiting for the target modules to consume the tuples transmitted by this module. The disk read operation resumes when the number of tuples in the net buffer falls below the low water mark. While the disk reads are suspended, the tuples in the write buffer are flushed out to disk. Thus the data flows in SDC are controlled so as to keep the disks idle time to a minimum. Our adaptive flow control scheme works well even under dynamically varying loads, which are confirmed by the detailed simulation [6]. Usually the disk I/O and the network I/O are treated completely independently. However as shown in Figure 3, the tasks from both the disks and the network are equivalently processed in our application. To ease the programming, these two I/Os are unified. There is no distinction between these two, which is also one of the features of SDC-OS.

On top of the SDC-OS, SDC-DB was constructed, which is a collection of processes dedicated to each database management function. The processors of each module run data processing processes, which perform the relational algebraic operations using the four primitives described above. On the control processor, several processes such as Module Control Process, Disk Manager, Network Manager Process, Memory & DMA manager, and SCSI driver are activated. The Module Control Process is responsible for all the activities occurring in a single module. SDC-I is connected to the server machine, where the SQL compiler, the scheduler and the coordinator are invoked. The last one synchronizes the operations among the multiple modules. Barrier synchronization is necessary for phase transitions such as the switch from the i-th bucket to the $(i + 1)$-th bucket, and the transition from the build phase to the probe phase.

5. Performance Monitor

It is usually difficult to understand the behavior of parallel processing systems, since so many activities run simultaneously. This stimulates the research on the performance monitoring tool and its visualization system. The majority of such tools developed so far are for scientific applications and focus on just CPU utilization. Since database processing requires a large amount of I/O to the secondary storage system, I/O behavior and buffer memory utilization are also influential factors to the overall performance.

The SDC performance evaluation tool consists of performance measurement tools and performance visualization tools. There are two approaches for the performance monitor: hardware monitor and software monitor. The former can measure the system with minimum interference but its dedicated hardware incurs a high cost. The latter is easy to introduce but usually has side effects which are not negligible. Therefore we integrated these two approaches to form the SDC performance monitoring system. We developed the bus monitor as a hardware monitor and the resource monitor as a software monitor. The bus monitor is designed to measure the utilization efficiency of the H-bus and C-bus which can be found in Figure 1 and examine the I/O activities of the disk drives. Since all the data from the disk flows through the bus, I/O behavior can be monitored by examining the bus. The most sensitive component in SMP is the common bus, whose bandwidth determines the total number of processors in the system. Especially in database applications, data movement is the major task, which produces a heavy load on the common bus. Thus the traffic on the bus must be carefully examined. The resources which try to issue H-bus requests are four processors, the control processor, two disk controllers, and the network adaptor. C-bus is accessed by four processors and the control processor. Thus there are in all 13 bus grant signals, and the bus monitor can select four of them to watch at a time. The active time of these signals are cumulated by the hardware counters in the bus monitor. The monitor has two kinds of precision modes: 50 nsec and 100 nsec, where the bus cycle of the H-bus is 50 nsec. For each counter, 2 MB RAM are prepared to store the traffic data. The most precise measurement mode can monitor the system for 54 seconds. A 216 seconds-run can be monitored with a rougher measurement.

The resource monitor embeds the monitor routine into each of the processes and measures the CPU utilization efficiency of the four processors and the control processor. The amount of memory allocated for each buffer (read buffer, write buffer, bucket buffer, and net buffer) is also monitored by the resource monitor. The data memory space is managed in the unit of page and the memory allocation tables are kept in the control memory. The control processor can take the statistics by reading the control information on the control memory, which maintains the number of pages assigned for each buffer and free pool. The visualization tools of SDC-I consists of SDC-Tacho and SDC-View. The former is the on-line monitor tool which runs on the server machine and shows the resource utilization efficiencies whose statistics are transmitted by the resource monitor on the

control processor. The monitored data is visualized as the tachometer on the window. Most of the resource activities can be summarized in just one display, which helps us understand the global behavior of SDC and aids in debugging the system software. SDC-View takes the two files produced by the bus monitor and the resource monitor. After the execution it displays the overall performance data, which are mainly used for the detail analysis. Figure 4 shows the resource utilization time chart by SDC-View. For ease of understanding, the expanded Wisconsin benchmark (1 Mtuple Join A Sel B) with naive parallel hash join was run on SDC-I. Two relations, R and S are initially declustered over the two modules. In Figure 4, the top five charts shows the CPU utilization of the control processor and the four processors. The relational database processing load is equally distributed over the four processors. The next four charts, in Figure 4, show the memory utilization of each buffer. The read buffer is almost always empty, which means that the processors are sufficiently fast to consume the pages, keeping up with the data stream from the disks. The behavior of the write buffer is like a saw. Since the write buffer has a high water mark, its contents are flushed out when the number of tuples reaches this mark. Once it goes below the low water mark, the disk read operation resumes. The last three charts shows the utilization of the H-bus. It shows that the system works so well that the disks have almost no idle time and are

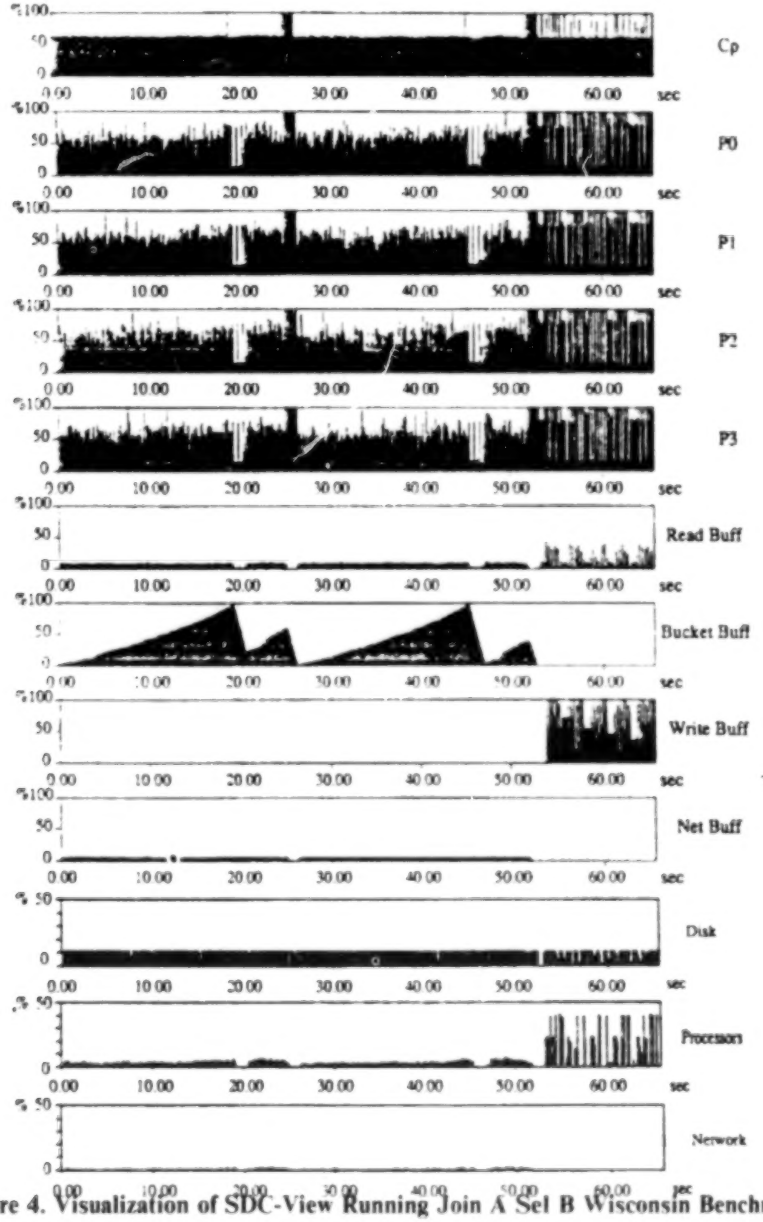


Figure 4. Visualization of SDC-View Running Join A Sel B Wisconsin Benchmark

almost always busy. The bus is not saturated, but still has room for additional disks and processors.

As shown in Figure 4, Join A Sel B executes in 65 seconds. This performance is sufficiently high compared with the current commercial relational database systems.

6. Conclusion

This paper explores the feasibility of the massively parallel processing systems for parallel relational query processing. The query processing applications contain a high degree of potential parallelism. Through the use of a sophisticated parallel algorithm, we can efficiently exploit the inherent parallelism. In order to examine the feasibility of parallel query processing, an experimental testbed was built from scratch. The hardware system fully utilizes commodity devices except for the special purpose interconnection network with its tuple counting mechanism and dedicated disk controller. For data intensive applications like database processing, data movement is the major task rather than the computation. The software system controls the flow of data efficiently so that the data stream from the disk is disturbed as little as possible. Although only two modules were developed, the performance evaluation results convinced us that the proposed approach is very powerful and promising. The pilot system achieved our goal of high performance. The activities in the parallel system are very difficult to understand. A performance monitoring system was also developed, which integrated both the special hardware based bus monitor and the software monitor. Visualization tool, SDC-Tacho and SDC-View were very useful to grasp the global activities of the system.

The modular architecture gives the ability to flexibly scale the system and the bucket spreading hash join algorithm allows an almost linear increase in performance. We do not say that this is the ultimate architecture for parallel query processing. Current technology increases the performance of the microprocessors and decreases its price dramatically due to mass production. In order to increase the performance/cost ratio, the design should employ commodity elements as much as possible. However through advances in sophisticated CAD systems, the designer will be able to develop their own chips much more easily. Future parallel database servers are expected to integrate several super chips of special purpose hardware in them.

Acknowledgment

Mr. Stephen Davis polished up the quality of English significantly.

References

[1] Calino, Jr., F. and Kostamaa, P., "Exegesis of DBC/1012 and P-90," *Teradata Advanced Concepts Laboratory (TACL)*, 1992.

[2] DeWitt, D.J., Gerber, R.H., Graefe, G., Heytens, M.L., Kumar, K.B. and Muralikrishna, M., "GAMMA—a high performance dataflow database machine," *Proc. of the 12th Int. Conf. on VLDB*, pp 228-237, 1986.

[3] Faudemay, P. and Mhiri, M., "An associative accelerator for large databases," *IEEE MICRO*, pp 22-34, 1991.

[4] Fushimi, S., Takeda, Y., Iwasaki, H., Komiya, F. and Nakagome, H., "A database processor greo," *Journal of Information Processing Society of Japan*, Vol 33 No 12, pp 1416-1423, 1992.

[5] Graefe, G., "Encapsulation of parallelism in the volcano query processing system," *Proc. of ACM SIGMOD Int'l. Conf. on Management of Data*, pp 102-111, 1990.

[6] Hirano, S. and Kitsuregawa, M., "A high performance parallel I/O model and its deadlock prevention/avoidance technique on the super database computer (SDC)," *Proc. of HICCS-26, IEEE 26th Hawaii Int. Conf. on Computer Sciences*, 1993.

[7] Hollaar, L.A., "Implementation and evaluation of a parallel text searcher for very large text databases," *Proc. of HICCS-25, IEEE 25th Hawaii Int. Conf. on Computer Sciences*, Vol 1, pp 300-307, 1992.

[8] Hong, W. and Stonebraker, M., "Optimization of parallel query execution plans in XPRS," *Proceedings of the First International Conference on Parallel and Distributed Information Systems*, pp 218-225, 1991.

[9] Inoue, U., Satoh, T., Hayami, H., Takeda, H., Nakamura, T. and Fukuoka, H., "A relational database processor with hardware specialized for searching and sorting," *IEEE MICRO*, Vol 11 No 6, pp 61-70, 1991.

[10] Kitsuregawa, M., Hirano, S., Harada, M., Nakamura, M. and Takagi, M., "The super database computer (SDC): Architecture, algorithm and preliminary evaluation," *Proc. of HICCS-25, IEEE 25th Hawaii Int. Conf. on Computer Sciences*, pp 308-319, 1992.

[11] Kitsuregawa, M., Nakayama, M. and Takagi, M., "The effect of bucket size tuning in the dynamic hybrid GRACE hash join method," *Proc. of Int. Conf. on VLDB*, pp 257-266, 1989.

[12] Kitsuregawa, M., Nakano, M., Harada, L. and Takagi, M., "Functional Disk System for relational database," *Proc. of 3rd Int. Conf. on Data Engineering*, pp 88-95, 1987.

[13] Kitsuregawa, M., Nakano, M. and Takagi, M., "Query execution for large relations on Functional Disk System," *Proc. of 5th Int. Conf. on Data Engineering*, pp 159-167, 1989.

[14] Kitsuregawa, M. and Ogawa, Y., "Bucket Spreading Parallel Hash: A new parallel hash join method with robustness for data skew in super database computer (SDC)," *Proc. of 16th Int. Conf. on VLDB*, pp 210-221, 1990.

[15] Kitsuregawa, M., Tanaka, H. and Moto-oka, T., "GRACE: relational algebra machine based on hash and sort—its design concepts—," *Journal of Information Processing*, Vol 6 No 3, pp 148-155, 1983.

[16] Kitsuregawa, M., Yang, W., Suzuki, T. and Takagi, M., "Design and implementation of high speed pipeline merge sorter with run length tuning mechanism," *5th International Workshop on Database Machines*, pp 144-157, 1987.

[17] Kojima, K., Torii, S. and Yoshizumi, S., "IDP—a main storage based vector database processor," *5th International Workshop on Database Machines, also in Database Machines and Knowledge Base Machines*, Kluwer Academic Publishers, eds. M. Kitsuregawa and H. Tanaka, pp 47-60, 1987.

[18] Kudo, T., "The Data Base Assist," *Journal of Information Processing Society of Japan*, Vol 33 No 12, pp 1431-1435, 1992. (In Japanese)

[19] Lee, K.C., Hickey, T.M., Mak, V.W. and Herman, G.E., "VLSI accelerators for large database systems," *IEEE MICRO*, pp 8-20, 1991.

[20] Matsuda, S., Inoue, S., Shimakawa, K. and Yamada, A., "A database operation processor: DBE," *Journal of Information Processing Society of Japan*, Vol 33 No 12, pp 1424-1430, 1992. (In Japanese)

[21] Nakayama, M., Kitsuregawa, M. and Takagi, M., "Hash-partitioned join method using dynamic destaging strategy," *Proc. of the 14th Int. Conf. on VLDB*, pp 468-478, 1988.

[22] Takahashi, K., Yamada, H. and Hirata, M., "A string search processor LSI," *J. Information Processing*, Vol 13 No 2, pp 183-189, 1990.

[23] Tsuchida, M. and Torii, S., "Integrated database processor IDP and filtering processor RDSP," *Journal of Information Processing Society of Japan*, Vol 33 No 12, pp 1409-1415, 1992. (In Japanese)

[24] Watson, P. and Townsend, P., "The EDS parallel relational database system, parallel database systems," *Proc. of PRISMA Workshop*, pp 149-166, 1991.

Combined-Cycle Power Generation Technology

Advanced, Future Technologies for Combined-Cycle Power Plants

94FE0761A Tokyo TOSHIBA REVIEW in Japanese 1 Apr 94 pp 250-252

[Article by Akio Ohji]

[Text]

I. Introduction

In recent years, efforts have been made to introduce advanced combined-cycle plants that use highly efficient 1,300°C class gas turbines, as these will conserve resources and preserve the environment. In order to meet the demand, Toshiba is improving its advanced combined-cycle power plant production system by strengthening its organization and expanding production facilities. The company also signed a contract with General Electric in May 1992 for joint manufacture of 1,300°C class gas turbines.

In the field of gas turbine research and development, a 1,300°C class, 15MW gas turbine test plant was completed in January 1993; as data is gathered, the plant is being prepared for future increases in temperature.

Here, the latest advanced combined-cycle technology is introduced, and future increases in efficiency and fuel diversification are reviewed as well.

II. Development of Combined-Cycle Technology

2.1 Practical Application of Gas Turbines for Power Generation

After the war, Toshiba was the first to develop a gas turbine, which was delivered to the Railway Technical Research Institute (now the Transport Technical Research Institute). This turbine is still being displayed at the Institute as a historical monument to domestic gas turbine development.

Later, a large number of gas turbines were manufactured in cooperation with BBC, a European gas turbine manufacturer. However, in the United States gas turbine temperatures were increased based on aircraft engine technology; this trend was true in Japan as well, and in the beginning of 1980 a contract was signed with GE to manufacture 1,100°C class gas turbines, with another contract signed in May 1992 to manufacture 1,300°C class turbines.

Toshiba has recently handled 1,100°C class combined-cycle power plants such as Tokyo Electric's Futtsu No. 1 system (1,000MW) and Chubu Electric's Yokkaichi No. 4 system (560MW), and is currently handling 1,300°C class combined-cycle plants such as Tokyo Electric's Yokohama No. 7 system (1,400MW). Toshiba recently participated in the Moonlight Project as well, and is working towards accumulating gas turbine technology by completing a 1,300°C class 15MW gas turbine test plant.

2.2 Practical Application of a Heat Recovery Type Combined-Cycle Plant

At first, exhaust recycling models accounted for most combined-cycle plants, which use gas turbine exhaust as air for boiler combustion. However, heat recovery models that collect turbine exhaust in a heat recovery boiler and operate steam turbines with the steam produced became more efficient as gas turbine temperatures were increased, and at the present time heat recovery models have become the mainstream.

The thermal efficiency of heat recovery type combined-cycle plants improves by increasing gas turbine temperatures; 43 percent thermal efficiency has been achieved with a 1,100°C class and 48 percent with a 1,300°C class gas turbine combination. Thermal efficiency of 50 percent or more is expected with a 1,500°C class gas turbine (Figure 1).

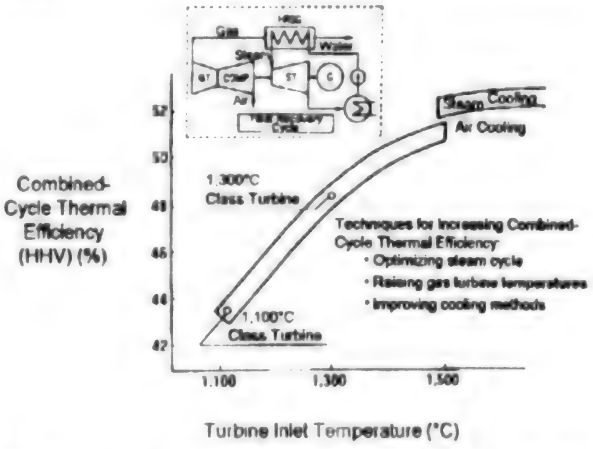


Figure 1. Gas Turbine Inlet Temperature vs. Combined-Cycle Thermal Efficiency. Improvements in thermal efficiency of combined-cycle plants due to increases in gas turbine inlet temperatures are shown.

III. New Technologies in Advanced Combined-Cycle Plants

3.1 System Characteristics

The advanced combined-cycle system consists of a 1,300°C class gas turbine, a reheating three-pressure heat recovery boiler that recovers as much of the turbine's waste heat as possible, and a reheating mixed-pressure steam turbine which changes the steam into mechanical energy (Figure 2).

The axial output for this kind of three-pressure reheat single shaft combined-cycle is 238MW for 60Hz and 343MW for 50Hz. Forty-eight percent thermal efficiency

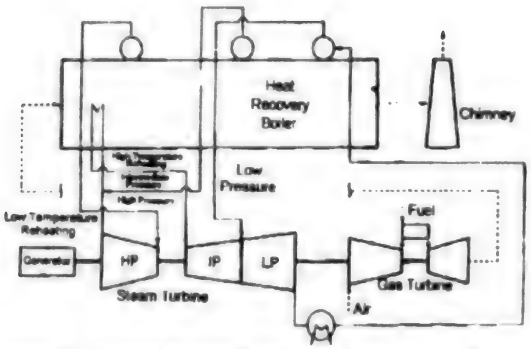


Figure 2. Three-Pressure Reheat Steam-Cycle System. The figure shows a combined-cycle system that employs a three-pressure reheat steam cycle that recovers as much of the gas turbine's waste heat as possible.

can be attained with a transmitter. Moreover, by combining a dry low-NO_x burner with a high efficiency denitration device incorporated into the heat recovery boiler, NO_x emissions are kept at levels low enough to be environmentally safe.

As for the power train, which consists of the gas turbine, steam turbine, and generator, a high and low pressure integral rotor developed for combined cycle plants was recently put into the steam turbine, and the casing was scaled down, which makes the power train more compact. The number of periodic inspections was also reduced. In addition, a rational layout was planned, with the gas turbine exhaust turned into axial flow exhaust and the heat recovery boiler placed horizontally (Figure 3).

3.2 Component Characteristics

3.2.1 1,300°C class gas turbine

GE's 1,300°C class gas turbines come in two standard models, the MS7001FA for 60Hz and the MS9001FA for 50Hz; respective unit outputs are 159MW and 227MW, approximately twice that of current 1,100°C class turbines. Gas turbine inlet temperature is 1,288°C at the moving blade inlet, and thermal efficiency is approximately 36 percent.

The gas turbine is supported front and back by two bearings, and the middle bearing employed in the 1,100°C class turbines has been eliminated, making the turbine easier to maintain. The drive shaft is a cold end drive model positioned next to the compressor, improving reliability. In addition, the gas turbine exhaust is axial flow, so that the connection to the heat recovery boiler is smooth; this is meant to reduce exhaust loss (Figure 4).

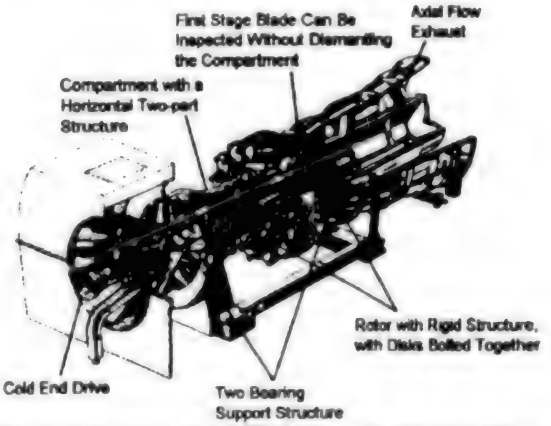


Figure 4. Features of 1,300°C Class Gas Turbine Structure

3.2.2 Steam Turbine

This is a compact single casing mixed pressure reheat steam turbine that employs an integral high and low pressure rotor recently developed for combined cycle plants. The high and low pressure integral rotor is made of second generation material designed to improve creep strength in the high temperature section and tensile strength and toughness in the low temperature sections. These were developed based on improvements in the components of first generation rotor materials, which already had many positive results.

Forty-inch titanium blades were used for the 60Hz and 42-inch blades for the 50Hz final stage longitudinal blades, making a single casing possible.

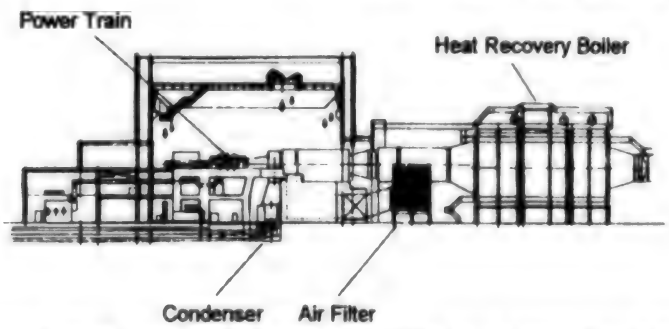


Figure 3. Power Plant Layout. Waste gas loss is reduced by means of gas turbine axial flow exhaust, and the layout was rationalized by installing a horizontal heat recovery boiler.

3.2.3 Generator

This is a three phase revolving field magnet type, with the stator being water or hydrogen cooled and the rotor being hydrogen cooled. The output is 350MW for 50Hz, and because the starting torque exceeds the actual torque converter capacity, a static (thyristor) starter generator has been adopted, which utilizes the generator as a thyristor motor when starting.

3.2.4 Heat Recovery Boiler

This is a three-pressure reheat model that can effectively utilize the gas turbine's waste heat. It is also a natural cycle boiler meant to reduce power and improve reliability.

The boiler's heat transfer pipes employ fin tubes, so that heat is effectively recovered even in the low temperature areas. Earthquake resistance was improved by placing the boiler horizontally, reducing its height. In addition, the heat transfer pipes are also the lower support structure, which reduces the weight of the boiler support structure components.

3.3 Advanced Information Control System

The combined-cycle control system can efficiently operate a combined-cycle plant, and its functions are decentralized and stratified for handling the primary components. It is superior in terms of reliability, controllability, economy and maintainability due to its digital control devices, and uses the latest man-machine interfaces such as CRT (image display device) operation, which optimizes the system and makes it more compact.

IV. Future Prospects

Increasing the efficiency of LNG (liquefied natural gas) fired combined-cycle plants requires higher gas turbine inlet temperatures. Points to consider in order to raise temperatures include development of heat-resistant materials and improvements in cooling technology. Technological developments for raising the temperature are now eagerly pursued, and 1,400°C class turbines will be realized in the very near future, although a rather long period of development will be necessary before the 1,500°C class will become a reality (Figure 5).

Efforts are also being made in the field of coal utilization, to put carbonation composite generators to practical use. So far we have been accumulating technology by participating in the United States's Cool Water Program and in elemental technological development of the Yubari Project on Carbonation. We are also currently participating in the Carbonation Association's Nakoso 200T/D pilot plant, and are promoting establishment of control system technologies and development of low NO_x burners.

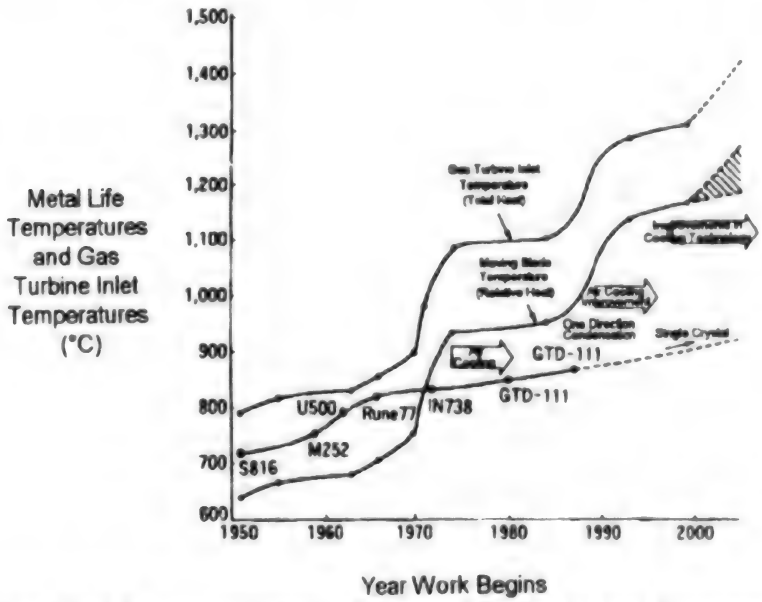


Figure 5. Forecast For Heat-Resistant Material and Improved Cooling Method. Gas turbine inlet temperatures will increase by using heat-resistant material and improved cooling methods.

System Engineering for Advanced Combined-Cycle Power Plants

94FE0761B Tokyo TOSHIBA REVIEW in Japanese 1 Apr 94 pp 253-256

[Text]

I. Introduction

Since Toshiba signed a gas turbine technical contract with General Electric (GE) of the United States in 1982, the company participated in constructing Tokyo Electric's Futtsu Plant No. 1 system, and as the primary contractor for Chubu Electric's Yokkaichi No. 4 system, Toshiba was responsible for coherent planning, construction, and trial operation of the plant. Overseas, Toshiba participated in Malaysian and Thai projects, and acquired a wide range of technologies as a combined-cycle plant manufacturer. 1,100°C class gas turbines are used in these plants, but at the present time each location is working on plans for an advanced combined-cycle (ACC) power plant using 1,300°C class gas turbines; this plant is even more efficient and has superior environmental characteristics. Table 1 gives the basic specifications for the company's planned ACC plant.

Table 1. Basic Specifications of Advanced Combined-Cycle Power Plant (combined-cycle mode: three-pressure reheat cycle, single shaft; atmospheric temperature: 15°C)

Item		60Hz regions	50Hz regions
Output at point of generation (MW/axle)		238	343
Thermal efficiency at point of generation (HHV base) (%)		48.8	48.8
Gas turbine		MS7001FA	MS9001FA
Heat recovery boiler		three-pressure reheat natural cycle	three-pressure reheat natural cycle
Steam turbine		mixed-pressure reheat turbine	mixed-pressure reheat turbine
NO_X policy	Gas turbine	dry low-NO_X burner	dry low-NO_X burner
	Denitration equipment	low-temperature denitration equipment	low-temperature denitration equipment

Both are single axle, and when combined with a three-pressure reheat natural cycle boiler, thermal efficiency exceeds 48 percent at an air temperature of 15°C. Below, we discuss the characteristics of ACC plant system technology.

II. Plant System Plans

2.1 Steam Cycle Selection

The waste gas temperature of 1,300°C class gas turbines is as much as 50°C higher than that of 1,100°C class turbines, making it possible to use an even more efficient steam cycle. Figure 1 shows the relationship between gas turbine combustion temperature and plant thermal efficiency with the steam cycle mode as a parameter.

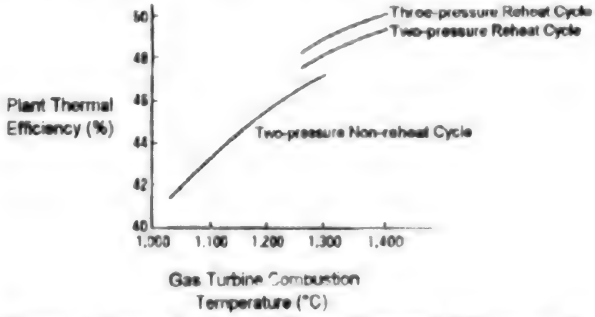


Figure 1. Steam Cycle and Plant Thermal Efficiency. By increasing gas turbine temperatures and making the steam cycle reheating and three-pressure, thermal efficiency can be raised approximately 6 percent compared to the 1,100°C class.

Thermal efficiency is improved about 4 percent compared to the 1,100°C class by increasing gas turbine temperature, and improved about 1 percent by using reheat mode and another 1 percent by using a three-pressure cycle. Furthermore, longer blades can be used for the final stage moving blades because humidity in the steam turbine's final stage is reduced by reheating.

2.2 Selection of Feedwater and De-aerating Methods

Along with selecting a three-pressure steam cycle, a number of methods can be considered for feedwater to the heat recovery boiler. Comparisons of transport, maintenance, and reliability are shown in Figure 2.

Case 1 integrates the low pressure drum with the de-aerator in order to remove dissolved oxygen in the feedwater, which is expensive as it requires using stainless steel pipes for the low pressure fuel economizer. Case 2 gives de-aerating functions to the condenser, and as in case 1, all of the feedwater passes through the low pressure drum. The pH of the low pressure drum is low, on the order of 9.4, making corrosion within the low pressure evaporator a problem. Cases 3 and 4 use de-aerating condensers, and the feedwater to each drum is independent, so that phosphate treatment of the low pressure drum is possible. In case 3, the feedwater to the high and intermediate pressure drums diverge where it exits the low pressure fuel economizer that all the feedwater passes through; in case 4, there is a separate low temperature fuel economizer for high, intermediate, and low pressures, and all feed pumps are put on the low temperature side.

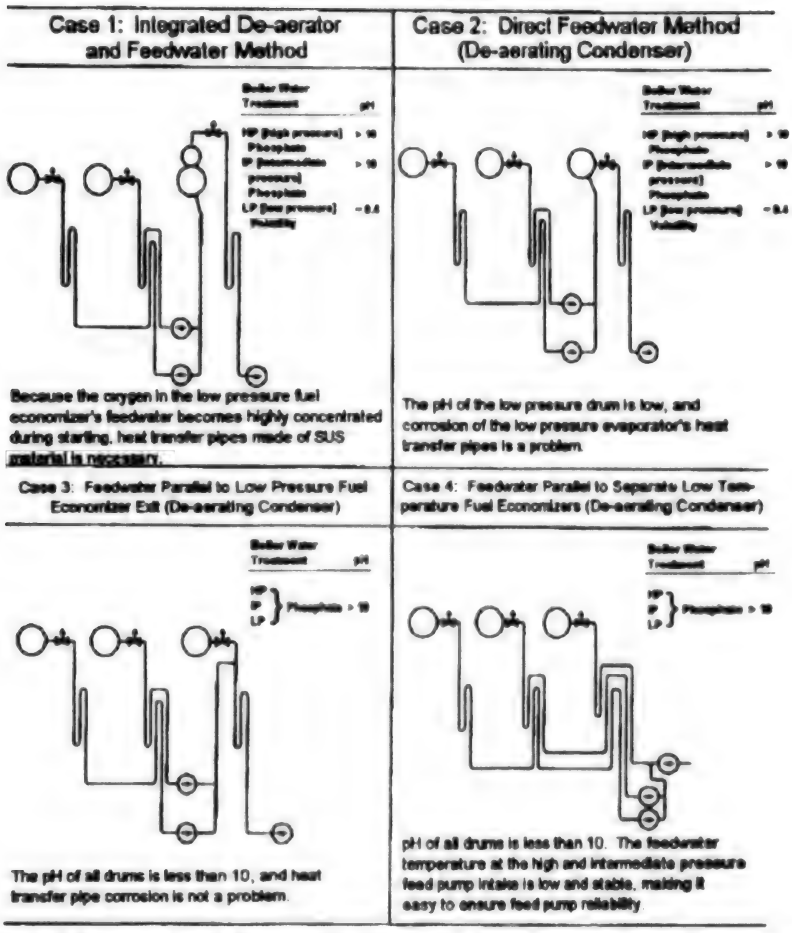


Figure 2. Comparison of Feedwater and De-aerating Methods. Along with selecting a three-pressure steam cycle, various kinds of feedwater and de-aerating methods were considered.

III. Characteristics of the Power Train Machinery

3.1 Gas Turbine

3.1.1 Basic Specifications

In 1992 Toshiba expanded the scope of its joint manufacturing contract with General Electric, which provided a system for manufacturing both types of 1,300° class gas turbines, the MS9001FA and the MS7001FA. Figure 3 shows a cross section of the MS9001FA.

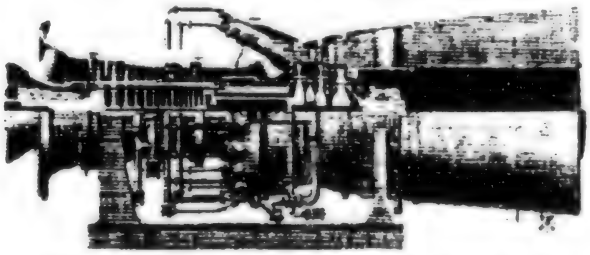


Figure 3. Cross Section of Gas Turbine MS9001FA. A 1,300°C class gas turbine, in which temperature, efficiency, and capacity has been increased.

The turbine's basic structure is based on the design ideas for current GE gas turbines, but during development the temperature, efficiency, and capacity were increased for application in combined-cycle plants. Specifically, the exhaust became axial flow, which is optimal for the combined-cycle layout, and the output shaft was taken from the compressor end having the least thermal change and a cold end drive model was adopted.

3.1.2 Dry Low-NO_x Burner

Japan's environmental policies follow the world's strictest standards, and these will become even stricter every year. Toshiba worked to develop a dry low-NO_x burner, which was put into the MS9001E, a 1,100°C class gas turbine with demonstrated performance and reliability. In the 1,300°C class, there is a tendency for NO_x to increase as temperatures do, but when improvements were added such as premixing part of the pilot fuel based

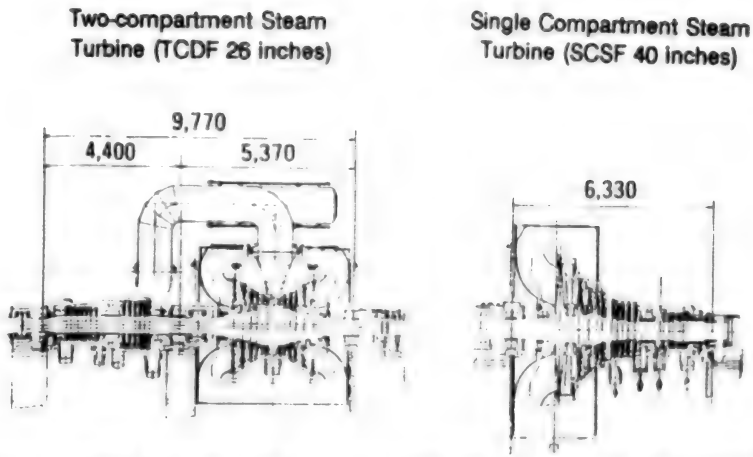


Figure 4. Comparison of Steam Turbines for Advanced Combined-Cycle Plant. By creating a single compartment reheat turbine, total length can be reduced approximately 3.5 meters.

on the premixed combustion method developed for the 1,100°C class, a greatly reduced NO_x level of 50ppm was achieved.

3.2 Steam Turbine

In a single-shaft ACC plant using the MS7001FA, the steam turbine is of the 85MW class, and until now a high and low pressure separated model was employed, which has one compartment for high and intermediate pressure and one for low pressure. Now, by combining a recently developed high and low pressure integral rotor material with titanium alloy 40-inch final stage moving blades, a single compartment turbine can be realized.

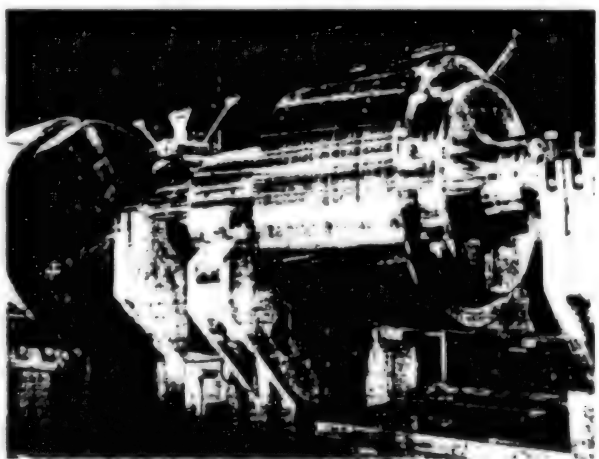
Figure 4 shows a comparison of this steam turbine with a two-compartment structure having a double current low pressure section with 26-inch blades.

The single compartment turbine's length can be shortened by approximately 3.5 meters and the width of the main casing can be reduced; a reduction in the number of compartments is beneficial from a maintenance standpoint, as it means a reduction in the number of periodic inspections and the number of spare parts. Toshiba has been making efforts in steam turbine technological development since the beginning of the 1980s, with the goal of making single compartment turbines more compact; first-generation rotor materials have already been used in more than 20 steam turbines having outputs of

amount of Cr, Ni, and Nb, and to maintain creep strength of the high pressure section by adding W.

Figure 5 shows a model rotor that was trial produced and evaluated in order to demonstrate manufacturing methods.

10^5 hours creep strength in the high pressure section was nearly identical to that of existing Cr-Mo-V steel for high pressure use; for the low pressure section, 0.02 percent durability is approximately 67 kgf/mm^2, and the FATT (fracture appearance transition temperature) is 23°C, all of which satisfy the targeted values for the mechanical properties of the rotor material.



3.3 Static (Thyristor) Starting Generator

The required shaft starting torque in the ACC increases as machinery size increases; therefore a static (or thyristor) starter is employed instead of the torque converter starter currently used, particularly in 50Hz single shaft combined-cycle plants. As shown in Figure 6, this system changes the voltage and frequency of the external power source by means of a static frequency converter, and uses the generator as a variable speed motor; one uses the steam roll at low speed and one is used from turning speed.

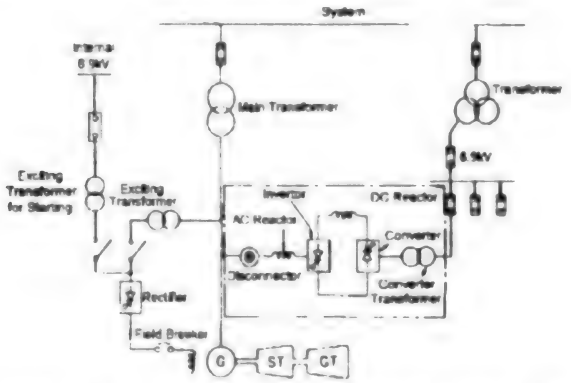


Figure 6. Configuration of Static Starting System. This changes the voltage and frequency of the external power source by means of a static frequency converter, and uses the generator as a variable speed motor to start the power train.

In the latter case, a pulse mode that forcibly breaks the current on the converter side is used, because when the frequency is low the generation voltage is low and cannot function as a load current invertor (LCI). In this case we expect an overcurrent loss on the rotor surface due to the high frequency current contained in the starter output; furthermore, because the centrifugal force produced in the rotor at low speed is small, contact between parts such as wedges is incomplete and local superheating in the rotor was also expected. Therefore improvements were made, such as changing the rotor wedge from the loose fit used thus far to a tight fit type, and changing the end damper to a full-length damper.

3.4 Power Train Layout

Because the generator has always been placed between the gas turbine and the steam turbine in single shaft combined-cycle power trains, the steam turbine must be moved in order to take out the generator rotor for inspection. In addition, the gas and steam turbines have separate thrust bearings, with a flexible coupling between the steam turbine and the generator.

As shown in Figure 7, the ACC plant has an axial flow gas turbine at the end of the power train shaft and the steam turbine is placed between the gas turbine and the generator, with the respective rotors joined by rigid coupling.

The gas turbine thrust bearing now takes the thrust load for the entire shaft. By placing the steam turbine's exhaust on the side facing the gas turbine, the respective thrust loads produced by the steam and gas turbines react in opposing directions and cancel each other, so that the thrust load is smaller than that of the gas turbine alone. An adequate separation between rated speed and purge revolutions was confirmed through analysis of hazardous speeds, and adequate separation between system frequency and its double frequency was confirmed through analysis of torsional vibration.

IV. Layout Plan

Figure 8 shows a three-dimensional CAD (computer aided design) example of a layout for a single shaft ACC using a 50Hz MS9001FA gas turbine.

A three-dimensional arrangement was selected for effective utilization of space, with the gas turbine, steam turbine, and generator placed on the third level and supplementary machinery other than the condenser placed near the steam power plant on the first level. The gas turbine's intake filter chamber is divided in two, and the intake duct is designed for downward intake, a good

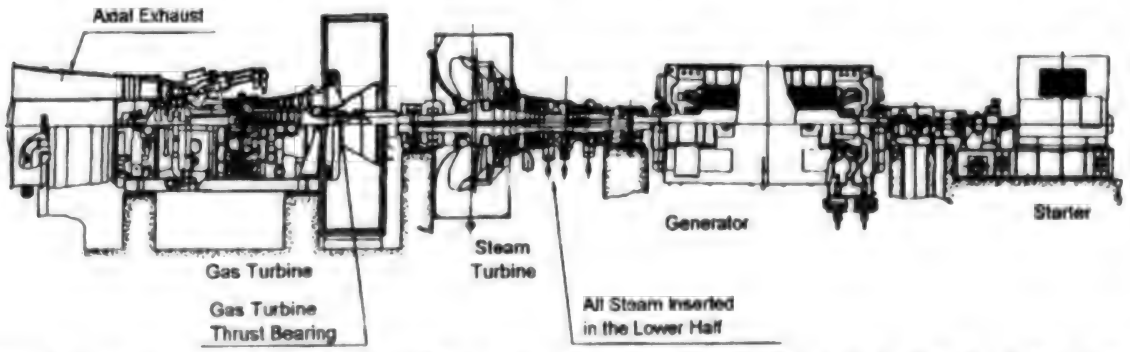


Figure 7. Power Train Configuration of ACC Plant. Components are connected to a single shaft by rigid coupling, in the order gas turbine, steam turbine, and generator.

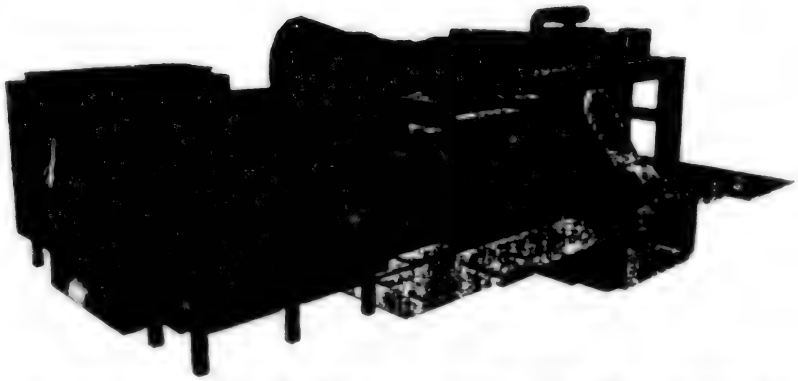
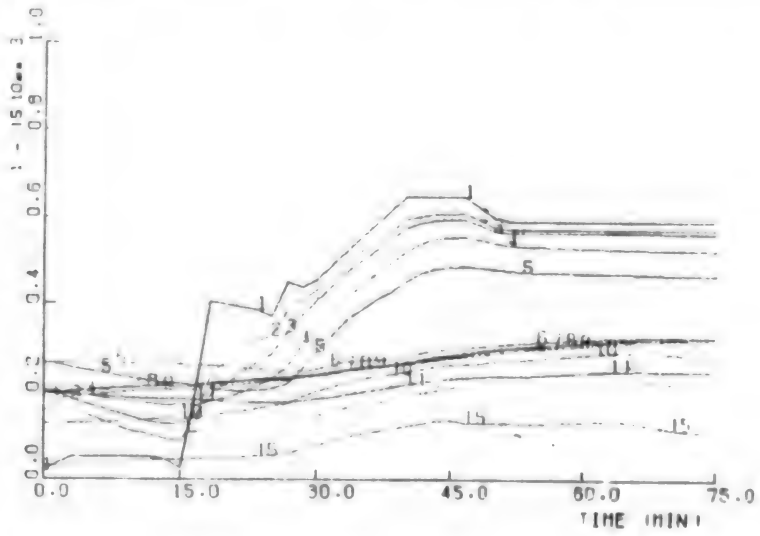


Figure 8. Power Train Equipment Arrangement. This is one example using three-dimensional CAD; it has a three-dimensional arrangement for effective utilization of space.

arrangement for conserving space. The heat of the gas turbine's waste gas is recovered by the heat recovery boiler, and the gas passes through the flue and up the chimney. In order to reduce NO_x, a low temperature denitration device was installed in the part of the heat recovery boiler where the temperature is approximately 330°C, and in combination with a low NO_x burner, this is sufficient in terms of compliance with environmental policies.



1. Gas turbine exhaust temperature
2. Number 2 superheater exit gas temperature
3. Number 2 reheater exit gas temperature
4. Number 1 reheater exit gas temperature
5. Number 1 superheater exit gas temperature
6. High pressure evaporator exit gas temperature
7. DENOX exit gas temperature
8. Intermediate pressure superheater exit gas temperature
9. Low pressure superheater exit gas temperature
10. High pressure Number 2 fuel economizer exit gas temperature
11. Intermediate pressure evaporator exit gas temperature
12. Intermediate pressure fuel economizer exit gas temperature
13. High pressure Number 1 fuel economizer exit gas temperature
14. Low pressure evaporator exit gas temperature
15. Low pressure fuel economizer exit gas temperature

Figure 9. Example of ACC Plant Simulation Analysis Results. Steam cycle response lags compared to the gas turbine, but rated operating conditions are reached in about one hour.

V. Characteristics of Plant Operation

Combined-cycle plants are expected to work as intermediate load plants. In planning a plant, we focus not only on the stationary characteristics but also on the changes of state for each part of the plant during non-stationary conditions, such as starting, stopping, and load changes. We need to obtain harmony between the gas and steam turbines and the heat recovery boiler, which differ in their transient characteristics, and establish appropriate operating procedures and control methods. The gas turbine has superior starting and stopping, and load follow-up, but because the steam turbine and heat recovery boiler have large volumes of water and metal thermal capacity, the primary factor for determining plant starting is the steam cycle.

Toshiba has a full-scale gas turbine and heat recovery boiler, and is analyzing ACC plant dynamic characteristics using verified analysis codes from this test equipment. Figure 9 shows the gas temperature change in the heat recovery boiler of a single shaft, three pressure reheat ACC plant during a hot start.

By performing this kind of simulation analysis, we can effectively study plant operating methods and optimize the system.

AIST, Toyo University Discover Microorganism That Decomposes Polycarbonates

94FE0401A Tokyo NIKKEI SANGYO SHIMBUN in Japanese 15 Feb 94 p 5

[Text] AIST National Institute of Bioscience and Human Technology, JSP, a major manufacturer of foaming resin, Tsukuba, and Toyo University have jointly discovered microorganisms that decompose plastic resins that are synthesized from CO_2. They belong to aliphatic polycarbonate. The only material applicable to biodegradable plastics has been polyvinylalcohol that has bonding ester. More materials are expected to be applied to manufacture biodegradable plastics since the microorganisms can decompose them.

The microorganisms that were collected from the rivers and soil in the Kanto area were cultivated in culture medium containing polycarbonates and seven strains of microorganisms were isolated. The researchers have succeeded in decomposing a polymer that consists of approximately 2000 molecules. The microorganisms decompose polycarbonate under aerobic conditions and the speed of decomposition is said to be somewhat slower compared to the speed of decomposition by the microorganisms for polyester.

Polycarbonate is a new material synthesized from CO_2. It can be utilized in many shapes and forms such as intermediate material for polyurethane, films, and ingredients for fine chemicals. It has a higher melting point than polyester plastics and it is expected to have industrial usages.

The research group plans to continue analyzing the mechanism of decomposition by the microorganisms explaining, "The way that these microorganisms break bond is different from the decomposition by the microorganisms for polyester." Since the microorganisms have been collected in various places, the research group believes that they exist widely in the environment.

Ube Industries Succeeds in Long-Distance Transportation of Coal-Water Mixture

94FE0401B Tokyo NIKKEI SANGYO SHIMBUN in Japanese 15 Feb 94 p 15

[Text] Ube Industries has succeeded in testing long-distance transportation of CWM (coal-water mixture). The ship made a round trip voyage between Ube City, Yamaguchi-ken, where the factory is located, and Singapore. Product changes caused during the trip were checked for serviceability. It was concluded that long-distance transportation was possible and based on test results, its utility will be recommended to electrical companies for the future.

The composition of the CWM consisted of 70 percent finely powdered coal, 30 percent water and small amounts of additive. It can be shipped in a tanker similar to the ones used for crude oil, and upon unloading, it can be stored in tanks. Compared to coal, the merit is that environmental preservation is easier.

Ube Industries is planning a project where CWM manufactured in New South Wales State, Australia, could be shipped to Japan. Until now, the manufacturing of CWM and the goal for practical usage has been attained through repeated combustion tests during actual use, but the problem remained whether the product could withstand the long-distance transportation from Australia.

This time, with the cooperation of Nihon Yusen, Nitsho Iwai, Tsurumi Transportation (Tokyo, Minato), a round trip from Ube to Singapore which involved a larger distance than one way from Australia was enforced. Two thousand tons of CWM was shipped requiring about 20 days. The influence from the rolling of the ship and the affect of tropical heat on the quality of the product was checked. As a result, it was concluded that long-distance transportation is possible using a crude oil tanker that has been reconstructed.

The Company claims that, "by completing the transport test, it has cleared the technological problems for practical utilization of CWM." Consequently, its utility in Japan will be emphasized. As source for fuel for thermal power plants, products from China have already started to be used by some parts, but in order to maintain a stable supply, CWM from Australia is being pushed for sale. If negotiations materialize, it is said, a plant will be constructed at Newcastle Port, New South Wales State.

Ministry of Transport To Develop Fuel Cell Prototype Vessel

94FE0401C Tokyo NIKKEI SANGYO SHIMBUN in Japanese 15 Feb 94 p 13

[Text] According to the fiscal 1994 government budget plan on resurrection negotiation for the Ministry of Transport concerning ship construction, by February 14, development of fuel cell vessels was approved. Instead of the diesel engines and gas turbines that have been used up to now for powering ships, an investigation into resurrecting fuel cells that are clean and heat efficient is to be undertaken, and a four-year plan to design and develop a protocol vessel will be in progress. The approved government budget for the first year to be used for the "next generation vessel research and development fund" was ¥200 million. The original unofficial announcement called for zero assessment. This project expects an equal donation from the private enterprises, so actually the total cost of the project will be ¥400 million.

The fuel cell operates by extracting electrical energy from reacting hydrogen and oxygen. The systems of generating electricity that are about to become practical use are the phosphoric acid type and the fused carbonate type. A protocol vessel will be built upon studying the characteristics of a ship that hauls fuel systems that use liquid natural gas (LNG) or methanol to generate electricity.

Under the same subject of expenditures for the next generation vessel development, ¥673 million for research and development for techno-super-liner (TSL) has been approved during the original plan. Fiscal year 1994 will be the final year for the two types of experimental vessels to be completed.

In addition to the field of ship construction, for environmental preservation measure, ¥164 million was approved out of a requested ¥175 million. The breakdown was ¥45 million for study of exhaust gas measures such as nitrogen oxide (NO_x) products and ¥119 million for oil spill prevention measures. For half of the support project, the project scale was doubled respectively. In addition, as a measure devised to satisfy the double haul tanker regulation by the International Maritime Organization (IMO), the fund ratio of the Kaigin fund for shipping industry will be raised. Until the present, it has been 50 percent or 60 percent but it will be revised to a uniform 60 percent.

Tokyo Gas Co. Develops Co-Generation System for Small Space

94FE0401D Tokyo NIKKEI SANGYO SHIMBUN in Japanese 15 Feb 94 p 15

[Text] Tokyo Gas Company has developed a co-generation system that realizes low cost and small space by directly casting exhaust heat into a heat exchanger. The co-generation system presently being used utilizes exhaust heat coming from the absorption refrigerator to create cool water for the cooling system. However, in cases of small scale systems, the exhaust heat temperature has been low and efficiency poor for the relative large size of the plant. The new system, compared to the Company's present product, eliminates over 30 percent installation space in addition to a cost reduction of around 10 percent. By August, the new system will be installed at the Energy Technical Research and Development located in Minato-ku, Tokyo, for actual testing.

Co-generation up to now has used exhaust heat ranging from 80 to 90°C that has been exhausted from gas turbines and gas engines. This was used for the combined hot water absorption refrigerator and gas absorption cold hot water vessel using double cold gas generating sources. In the new system, the exhaust heat is being collected into a heat exchanger and directly cast into gas absorption cold ho' water cycle. The hot water in the cycle heats the liquid refrigerant and cold gas is created through evaporation. The claim is that improvement in performance of the heat exchanger has made it possible in connecting to cold hot water.

Because the heat exchanger compared to the hot water absorption cold hot water vessel is far smaller, the entire system can be made smaller. Ordinarily, co-generation plants are installed in basements or on roofs where space is limited. For this reason, it is believed that miniaturizing will be of considerable merit.

With respect to cost, there is hardly any change in the gas consumption and operational costs, but cost of equipment is about 10 percent lower. The system is simpler, and therefore, the maintenance cost is expected to be lower. With the present system, it can be improved by investing approximately ¥1 million for a 100-ton scale refrigeration plant and by attaching a heat exchanger similar to the new type, the hot water absorption refrigerator can be eliminated.

Tokyo Gas Co. has switched a 50-ton class refrigeration co-generation system being used in the technical research lab to the new type. Continued performance tests have been applied and its stability has been confirmed. Consequently, a large size actual proof system will be installed and further improvements on the capability will be its goal. By next spring, the plan is to advance towards sales to the general public.

STA To Develop Environmental Monitoring System

94FE0401E Tokyo NIKKAN KOGYO SHIMBUN in Japanese 14 Feb 94 p 10

[Text] The conditions of our earth are changing, and in order to know the earth today, the "key" to analyzing what is happening will be the solution to the problems of the earth's environment. The Science & Technology Agency (STA) will set out to thoroughly investigate these changing conditions of the earth by starting from areas surrounding Japan with the use of the Venus Plan (a development where underwater cable is used for multi-purpose environmental monitoring network system).

Venus will utilize the existing underwater communication cable in addition to installing new fiber optic cables that would surround Japan and use it to operate as a basic information gathering network. At the same time, different types of sensors, observation stations, and underwater robots will be placed underwater in order to collect various information. The project will begin by applying the fiscal 1994 STA promotional control fund and the plan is to be completed in five to six years. When the network is completed, data necessary for the solution to environmental problems can be gathered on-line, and predictions of earthquakes and tidal waves, and conditions of ocean resources can be determined. At the same time, it will become possible to be a contributor to the observation of the whole earth, something that cannot be neglected for the sake of international cooperation.

The solution to environmental problems comprises a whole earth scale to study the varieties of phenomena that exist. In order to catch the phenomena, it is only natural to realize the importance of knowing all about the conditions of the ocean since it occupies 70 percent of the earth's surface. The data obtained would be of value in analyzing the earth's environmental changes. Furthermore, Japan is situated along the belt where the Pacific plate sinks into the inner earth, and for this reason, observation and prediction of earthquakes, tidal waves and the movements of ocean resources cannot be ignored.

Venus will function as the base for all the necessary ocean investigations, and at the same time, it will complete the missing data needed for Japan's ocean investigation also. According to plan, the system will activate coaxial underwater cable shaft used for underwater cable (cable type telephone communication network) (this will become obsolete and be replaced by fiber optic cables), and combine with the new layout of fiber optic cables surrounding Japanese waters that will create a high speed information treatment system. With this kind of system, information on the earth's core and the ocean will be collected on-line on a long term basis with observation recordings made in time series. The technologies that are going to be necessary, such as the non-contact coupling of underwater cables to the observation instruments and the connecting of fiber optics to the coaxial shaft cables, will be developed.

The underwater coaxial shaft cables that are to be put to practical use are TPC-1 (Ninomiya to Guam) and TPC-2 (Okinawa to Hawaii). The application for TPC-1 consists of a cooperative research enforced between Tokyo University Earthquake Research and IRIS, a U.S. communication relation research facility which collects data for earthquakes, tidal waves and electromagnetism.

The problem here is the method of connecting the observation equipment and the observation data to the cable. Until now, the method was to cut the underwater cable, drag it to the surface and perform the connecting. This called for hiring a cable layout ship and the requiring of reserve cables which meant higher establishing costs. With Venus, a study of non-contact coupling technology will be performed. Furthermore, in order to collect on-line data at necessary locations, the technology development of cable branching will be attempted. In addition, the development of various sensors and systems, and installation of the observation equipment will be enforced.

Concretely, it will be a long term underwater station for collecting data by ocean observation of our solid earth environment. Furthermore, sensors for water temperatures, soft concentrations, flow speeds, flow directions, and CO_2 concentrations will be in action. Also, measuring instruments for terrestrial magnetism, earthquakes, tidal waves, earth crusts and ocean surface fluctuations are being developed. Establishing long life batteries for lengthy observations, supersonic wave remote data transmission skills for delivering data 100 km away, and robotic unmanned submarines that will connect underwater cables to observation instruments are in the themes for development.

The lay-outs for the fiber optics will be concentrated on surrounding Japan by way of the Japan Sea, Pacific Ocean, Sea of Okhotsk, Tsugaru Straits and Okinawa open sea.

When this network is completed, it will help to understand the mechanisms of the warming of the earth, the clarification of resource formation at seabed of cobalt and manganese, and make possible the monitoring of underwater volcanoes. It will also be useful for searching resources, ship navigation safety, and disaster prevention for coastal countries.

Toyo Engineering Corp. Develops Equipment to Wash Machine Parts Using Ethane Substitute

94FE0401F Tokyo NIKKAN KOGYO SHIMBUN in Japanese 14 Feb 94 p 10

[Text] Toyo Engineering Corp. (TEC) has developed a washing machine for machine parts that uses xylene as solvent which is known for its high detergency. The goal was to find something to replace trichlorofluoroethane which has been banned since it was found to destroy the ozone layer. The product is said to effectively wash persistent oil and lubricating resin soils which cannot be removed by isopropyl alcohol (IPA) or cyclohexane. It will be added to the "Teclean" series for recycling type wash machines and its production on order basis has started. Detergency of xylene has been known but difficulty in its recovery has delayed its use in washing machines. The difficulty occurs during an attempt to purify by distillation because an azeotropic mixture containing approximately 40 percent water forms, and the removal of water is the problem. In order to solve this, TEC commandeered the chemical plant design technology by developing a purification distillation tower that distilled used xylene in two steps. By being able to recover and reuse high purity xylene, it was able to characterize a consistent cleaning condition to be maintained for the washed parts.

"Teclean" is a complete solvent recycle type washing machine system which includes plans towards environmental measures and low running costs. The newer

machines have included user consideration by limiting xylene capacity to less than 1000 liters so application for complying with fire regulations could be omitted. Also it is made to be installed in a small area. It is great for washing mass produced parts and therefore, the intention is to market the unit to automobile and wire drawing factories. The cost for a standard type is around ¥20 million. For a custom type, the cost would be around ¥50 million.

GIRI, Nagoya Stabilizes CO_2 Using Sepiolite

94FE0401G Tokyo NIKKAN KOGYO SHIMBUN in Japanese 10 Feb 94 p 5

[Text] [Nagoya] Government Industrial Research Institute (GIRI), Nagoya Industrial Research Laboratory (Director, Mr. Yasuhiko Kondo) has used sepiolite as a filler for chromatography and successfully stabilized CO_2. The purpose was to collect a large amount of CO_2 at the point of generation from thermal power generation plants, iron works, and oil and chemical companies. The characteristics of the development are the possibilities of separation of CO_2 from nitrogen at the exhaust temperature range, and the relative ease of acquiring and treating sepiolite. Promising data has been obtained from basic experiments made up to now. Starting fiscal 1994, the research project will be set in full force to establish the technology.

Sepiolite is a type of clay ore and its main constituents are magnesium oxide and silicon dioxide. When dried, it floats in water and is often used for tobacco pipes. In recent years, attention has been drawn to its unusual absorbency, high viscosity and catalytic characteristics. At the GIRI Nagoya Research Lab, during fiscal 1990 to 1992, a cooperative inspection of mineral deposits and research on methods of refining were performed with the Republic of Turkey, the country of origin of sepiolite production. New technology of removing impurities by hydrochloric acid was developed in conjunction with the discovery of new mining areas. On the other hand, attention on sepiolite as material for CO_2 stabilizer led to the progress of its research and development.

The discharge of CO_2, which is blamed for causing global warming, in the case of Japan, is said that more than half originates from exhaust gases from thermal power generators, iron works, and chemical companies. The treatment of this large quantity of exhaust gas should be settled before hand at its source. Material to be used for separation that will not be affected by exhaust heat, gas pressure, gas components, and is also economical is desirable, but in reality, a decisive product has not been available. On the other hand, sepiolite became a great attraction since it is available in quantity at low cost.

All it takes to process sepiolite is adjusting the grain size, temporary baking, filling the column, and passing gas through. It is a very simple setup. Nitrogen gas elutes first from the column, followed by CO_2 gas. Experiments made at higher temperature ranges of 400°C confirmed the separation of nitrogen and CO_2 still took place. The value for separation characteristics were similar to zeolite.

Zeolites are being studied for separation membranes but it is weak towards water and there is fear of damage during use. Consequently, the problem is the necessity for membrane preservation which adds to the manufacturing costs. On the other hand, sepiolite is a material of good stability. Its characteristic allows usage in grain state, the state required for separation by chromatographic adsorption.

The Laboratory has obtained perspectives that separations are even possible at temperatures as high as 500 and up to 600°C. For this reason, it has been decided the material is very promising for use in the separation of CO_2 where high temperature may exist in the area of the exhaust. The plan calls for full force research on practical use starting fiscal 1994.

Concretely, the Fine Ceramics Center (Nagoya City) will be the saucer to a 10-year plan starting fiscal 1994 advanced by the government-education-industry for "The Research and Development of Technology for High Temperature Separation, Collection, Re-usage of CO_2" plan and there is a good possibility that sepiolite will be included as a participant.

Nissan Motor Co. Develops Recycling Technology for Bumper

94FE0401H Tokyo NIKKAN KOGYO SHIMBUN in Japanese 8 Feb 94 p 13

[Text] Nissan Motor Co. (President, Mr. Yoshifumi Tsuji) announced on February 7 that, together with Mitsui Petroleum Chemical Co. (President, Mr. Shigetaka Sachida), they have developed a recycling technology for coated bumpers that can be formed as reusable bumper material. The recycle technology up to now has been unsatisfactory since the complete removal of coating was not easily available and expensive. For this reason, the bumpers that were collected at the markets could not be reclaimed as bumpers. With the new technology, the coated bumper is chemically treated with alkaline water under high temperature and with added mechanical stripping, applying the principle used for rice polishing machines. It has become possible to completely remove the coating at low cost and consequently, makes recycling of bumpers possible. Starting this month, the Company began recycling bumpers using the new technology to repair bumpers for the Blue Bird (U12 Model).

It has been difficult to completely remove the coating with the current recycle technology, and as far as reusing it as bumpers were concerned, the characteristic degradation due to impact, crack generations and other undesirable conditions occurred. For this reason, the recycling of coated heat plasticization resin bumpers could only be used for footrests or parts that do not have high

quality requirements. With the technology just developed, it is possible to use relatively low cost caustic soda as a solvent to treat and decompose. Consequently, the cost of treatment can be kept low. Furthermore, the used caustic soda can be neutralized, filtered, and it will form dilute salt solution as waste water. It will have no negative affect on the environment and it has the merit of being able to return to the ocean as sea water.

At present, the Company collects 3500 bumpers a month from Tokyo and Kanagawa prefecture. With respect to recycling bumpers, the factory collects approximately 2 tons including other waste materials. Mitsui Petro Chemical Chiba Factory will reclaim the wastes into bumpers and Nissan Motor Company's Ottpama Factory plans to manufacture bumpers for repair. At present, it will only be limited to bumpers for repairing Blue Birds but as recycling results and effects become known, eventually, expanded application to various other fields will be examined.

Tokyo Gas Co. Develops PEFC System Using City Gas

94FE0401I Tokyo NIHON KOGYO SHIMBUN in Japanese 2 Feb 94 p 12

[Text] Tokyo Gas Company (President, Mr. Kunio Anzai) announced on February 1 that, together with Mitsubishi Heavy Industry (President, Mr. Kentaro Aikawa), they have developed the world's first solid polymer fuel cell (PEFC) system (see photo [photo not reproduced]) using city gas for fuel. They have been successful in generating 5 kW of electric power. Test research is being performed so that by the summer of 1996, practical use could be possible. Theoretically, it is possible for each home to generate their own electricity by using the gas supplied to their homes.

The fuel cell system that has been developed constitutes a hydrogen sectional pattern refining vessel which directly produces highly pure hydrogen from the city gas (natural gas), and Mitsubishi Heavy Industries' solid polymer fuel cell. The plan is to use highly pure hydrogen as fuel to generate power. The production of hydrogen from city gas requires a refining vessel and its development has paved the road to the practical use of fuel cells operated from city gas.

The new development of the hydrogen sectional pattern refining vessel works as follows: (1) it decomposes city gas, mainly methane, by steam, (2) from a mixture of hydrogen, carbon monoxide and carbon dioxide, hydrogen alone is extracted by using a palladium membrane, and (3) the remaining components are burned. By this method, highly pure hydrogen is obtained. The technology in point was making the palladium membrane thickness to one-fifth for hydrogen to pass and this attributed to the high leap in efficiency in obtaining hydrogen.

So far, in order to obtain highly pure hydrogen, it has been necessary to use carbon monoxide metamorphism vessel and a hydrogen purifier. These apparati had a problem of becoming bulky. On the other hand, the refining vessel has a diameter of 28 cm and a height of one meter. This measures only one-fifth to one-tenth in size compared with the previous apparatus and amounts to considerable miniaturizing. The goal for the 21st century is to make available for practical use the new type fuel cell system which simply uses city gas.

Ataka Construction & Engineering Co. Develops Advanced Sewage Water Treatment System

94FE0401J Tokyo NIHON KOGYO SHIMBUN in Japanese 2 Feb 94 p 6

[Text] Ataka Construction & Engineering Co. (President, Mr. Yoshinao Tanaka) has developed a three course treatment process for sewage, namely, ozone oxidation, filtration by biologic material, and membrane filtration. The "high degree sewage treatment system" (see photo [photo not reproduced]) will use the treated water for man-made rivers, water fountains and resorts.

Concretely, the sewage treatment process will first use ozone oxidation to decolorize and decompose organics. Further removal will be made by biological filtration using microorganisms to rid organics and floating products. Finally, membrane filtration such as ozone disinfection and UF membrane (ultra-filtration membrane) are to be used to completely remove any material which may allow intestinal or colon bacteria to survive.

The treated water quality will be as good for using at resorts where man-made murmuring streams are used and for rivers where water volume is low.

It is said the machinery for the make-up system can be altered in accordance with each request.

Japanese Company Develops Wastewater Treatment System

94FE0401K Tokyo NIKKEI SANGYO SHIMBUN in Japanese 4 Jan 94 p 11

[Text] Maekawa Production Company (President, Mr. Tetsushi Maekawa), a company which develops maintenance tools and various systems, has come up with a new muddy waste water treatment system that applies foam, and they have begun receiving orders. The system allows organics and germs in the polluted water to adsorb on the surface of the foam, the foam is pressure sprayed, and is allowed to combust. It produces ash, not the caked dirt that always accompanied the prior system.

The treatment system, "Zeus," generates large quantities of foam of less than 0.1mm diameter in accordance to the foam fractionation rule by using the ultrafine grain foam generator. The soluble organics, germs and surface active products in the polluted water adsorb and float with the foam. Using a special nozzle, the foam is pressure sprayed into the furnace where it is combusted.

Up to now, the system consisted of using a centrifuge jointly with a wringer to remove the solids in the polluted water but the new system removes the solids by transporting them on the surface of the foam. For this reason, the disadvantage of the old system has been eliminated where the nozzle tended to plug, and combustion can be continued efficiently.

There are two systems in which "Zeus 200" has the ability to incinerate 190 kg per hour and "Zeus 100" will accommodate 100 kg per hour. The "200" system costs approximately ¥ 50 million. Both systems are installed on land and the height, including the chimney for the "200," reaches 5.2 meters.

The Company is involved in the manufacturing of airplane parts, puts together tools, and automates machinery, and its annual business is approximately ¥ 600 million. The Company has decided that the accumulated technology developed for the foam generation system can be utilized for industrial waste treatment and advancement into this field will be made.

Nagoya University Develops Precision Measurement AFM System

94FE0587A Tokyo NIKKAN KOGYO SHIMBUN in Japanese, 7 Mar 94 p 8

[Text]

Nondestructive Measurements of Micromachine Force, Position With an AFM

Nagoya—Micromachine R&D is booming. The sizes targeted are on the order of microns. The problem when machines that size are actually made is whether or not they will work as expected, and to assess that, the positions of fine structures and the forces acting on the materials must be evaluated by direct measurements. However, direct contact with the material to measure its forces can break the micromachine, and direct measurements of position using light are impossible if the size of the micromachine is smaller than the wavelength of the light. Professor Shigeru Okuma and colleagues at Nagoya University's Engineering Department tried to solve the problem with a new method and system that use an atomic force microscope (AFM). The research results have attracted attention, and the group will receive the Numata Commemorative Award for Research Papers at the spring meeting of the Japan Society of Precision Engineering that will be held at Tokyo University on 23 March.

Probe and Piezoelectric Device Also Employed, Micron-Level Measurements Possible

Although the setups are different for measuring force and measuring position, Okuma's system combines an AFM, one or more probes and one or more piezoelectric devices for both types of measurements. Brother Industries, Ltd. collaborated in producing the system. The system brings the tip of a probe, which is much finer than a 100-μm hair, close to a sample to make a measurement. Strictly speaking, it is a contact method of measurement, but the measurements are made in a nondestructive manner.

The probes used in Okuma's experiments are made of silicon nitride, which has a firm spring constant. The probes are 0.5 x 20 μm thick and 150 μm long. The tips are polished and can be made to move vertically, horizontally, or forward and backward by means of a piezoelectric device. AFMs can measure the forces acting between atoms and are used for evaluating elasticity in nanometer-scale regions and for measuring adsorptive forces, but this is the first time that an AFM was applied in [micron-level position and force evaluation and measurement]. Laser light irradiates a probe, and the probes flexure is measured from the difference between the phases of the laser light and the light reflected from the probe. At the same time, the piezoelectric device is controlled in such a way as to make the probe move, and force or position is measured by the magnitude of the voltage needed to make the probe move.

Semiconductor fabrication techniques are used in the fabrication of micromachines, but, in that case, the internal stress and adsorptive force of the thin-film materials affect each other slightly. Consequently, the shape of a micromachine will turn out to be different from that designed, and it may not function as thought. Even when the design is based on a specially shaped test piece that was prepared separately, the micromachine does not always turn out to be what was wanted. Thus, direct measurements to evaluate micromachines are needed, but their delicate structures break easily. Because of that problem, there is no advantage in using semiconductor fabrication techniques.

As for methods of measuring forces by means of direct contact with the sample, there were problems in that the forces applied to the materials were large—on the order of a millinewton—and the applied force could not be set arbitrarily. In contrast, with the method developed by Okuma et al., forces ranging from micronewtons down to several nanonewtons in strength can be applied in force measurements, and it was experimentally confirmed that direct atomic-level measurements can be made to determine positions.

Force Measurement Principles

When the tip of the probe nears the surface of an object, a repulsive force from the object's surface acts to bend the probe tip upward; a spring force that balances out the repulsive force acts in the downward direction. That force relationship is computed to determine the flexure of the probe; the other end of the probe, where it is held in place, is pushed up so that the probe returns to its original state. Conversely, when a probe tip that is touching the object is moved away from the object, an attractive force comes into play. This is the adsorptive force, which is determined from the maximum amount of flexure in the probe when the probe is moved away from the sample. Direct measurements can be made by inserting the probe tip into an opening in a micromachine. Measurements of a rotating object's torque are also possible, says Okuma.

Position Measurement Principles

This setup uses multiple probes moving in parallel in such a way that their motion mimics the contours of the surfaces of a sample and a reference, which is used as a yardstick, while the distances between the sample surfaces bumps and depressions are measured. Two probes set equidistantly from the reference, and one probe set on the sample side can be made to move longitudinally, horizontally or up and down by means of piezoelectric devices. The flexure of a probe is read by irradiating the probe with light, while the system judges the sample surface's bumps and depressions to control the piezoelectric device. The distance a probe moves is then determined from the magnitude of the voltage. The surface of the reference is scored at atomic-level dimensions so that it has a wavy shape with a regular pitch. The

dimensions of the sample's surface and openings are then measured by determining how many of those waves the probes passed over.

The measurement method developed is general purpose, and because it may also be used in semiconductor measurements, applications of the method are anticipated.

Nachi-Fujikoshi Corporation Develops YAG Laser-Robot Processing System

94FE0587B Tokyo NIKKAN KOGYO SHIMBUN in Japanese, 5 Apr 94 p 13

[Text]

Longer Lasting Fiber, No More Twisting

Nachi-Fujikoshi Corp. (Masamichi Honda, president) developed a YAG laser-robot processing system that combines a robot, pinhole-processing device, and laser-beam machine. Although several companies are already selling YAG laser cutting equipment, Nachi-Fujikoshi devised a new shape for the fiber-connecting parts so that the robot does not get tangled up in cable when it moves around, and the system can last up to 10 times longer than others of its kind. The company will exhibit the system at the welding show that will be held at the Chiba City Makucho Fair starting on the 13th, and will use that opportunity to start selling the system. The cost of the system, excluding the laser-beam machine, is ¥ 5.5 million. The company hopes to sell 20 systems per year.

The system's laser-beam machine is an ML-1330D model made by Miyahi Techno (average output, 250 W; cutting thickness, 3mm), and the robot is a high-speed, light-weight SC-15 model (load capacity, 25 kg). Another type of laser-beam machine can be used if so desired. The pinhole-processing device newly developed by Nashi-Fujikoshi has a four-joint parallel-link structure. Because the torch at the tip revolves around the center of a circle, the fiber cable will not get twisted up or broken off when the robot moves around.

Traces 99 Types of Patterns

Before, the fiber cable would twist around once with every action of the robot, causing the cable to get twisted up and break off after being used a few times. The new system operates over a range of diameters from 4 to 32mm, and can freely trace out up to 99 patterns.

The system's local precision in pinhole processing is within 0.02mm. Because a robot is used, the precision can be nearly 10 times higher than when only a laser-beam machine is used. Furthermore, the system cleanly finishes the shape of the cut piece. Even a beginner can easily operate the controller by means of menu selection, and there is also a code-input method for veterans.

Because the power supply and oscillator head are incorporated into one piece, the system can be used in dusty places and other such poor environments. The company will promote its uses in processing car bodies and mufflers, and the outer shells of household appliances.

Matsushita Electric Uses SHG to Develop New Compact Blue Laser

94FE0587C Tokyo NIKKAN SANGYO SHIMBUN in Japanese, 1 Apr 94 p 5

[Text]

Miniaturized SHG Laser Module Occupies 8 cc

Matsushita Electric succeeded in compactly modularizing a blue-violet laser that uses a secondary harmonic generation (SHG) device, which halves wavelength. To change the wavelength of laser light by means of an SHG device, fluctuations in the wavelength of the light must be kept down so that the wavelength matches the wavelength that suits the characteristics of the SHG device. Because of that, it was difficult to miniaturize such modules. The volume of the module that was developed is 8 cc, but Matsushita Electric is a trial producing a 4.5-cc module. By devising a different type of lens for inside the module, the company plans to make even smaller modules—as small as 1 cc—for use in consumer electronics.

The details of the research results will be announced at the meeting of the International Committee on Optics (ICO) that will be held at the Kyoto International Conference Center on the 4th.

The module developed by Matsushita Electric uses a lithium tantalate SHG device to convert 858-nm red laser light into 429-nm blue-violet light. When a 120-mW semiconductor laser is used as the light source, the output of the blue-violet laser light will be 2 mW.

In order for the SHG device to convert wavelength efficiently, the wavelength of the light from the laser light source must be controlled with an accuracy of 0.1 nm. Matsushita Electric placed a bandpass filter that takes advantage of interference between the light source and the SHG device, among other things, to suppress fluctuations in the wavelength of the light brought to the SHG device.

NTT Develops High-Precision Scanning Microscope for 3-D Atomic Level

94FE0812A Tokyo NIKKEI SANGYO SHIMBUN in Japanese 6 Jun 94 p 5

[Article by Yoshiro Hasuda]

[Text]

Distribution of Frictional-Force Strength Observed in Atomic Units

Nippon Telephone and Telegram Corp. (NTT) developed a frictional force microscope (FFM) that enables observation of the distribution of strengths of frictional forces acting on the surface of an object. Using an atomic

force microscope (AFM), which investigates the shape of an object's surface, and scanning the microscope's probe, which acts as a sensor, directly over a sample, NTT researchers succeeded in capturing an accurate picture of the frictional forces on the surface of a sample. We can expect broad applications of this technology, such as in the production of higher-performance mechanical parts and electronic parts and in controlling the pliability of fibers. Although there has been a sequence of developments of scanning-type probe microscopes that enable observation of objects at the atomic level, attempts to open up new areas in materials research will become more vigorous with the addition of the FFM.

The development of an FFM has been attempted before, but NTT's newly developed microscope gets a more accurate grasp of the distribution of frictional forces on the surface of an object. The new microscope separately detects the vertical displacement and degree of torsion of a lever to which the probe is attached.

Also, problems, such as damage to the object's surface, were encountered in past observations of frictional force distribution. With the new microscope, however, better performance has been realized for the first time—even though the probe is pressed down onto the object's surface, it is done with such a weak force that the surface is not damaged.

In order to separately capture the vertical displacement and torsion of the probe lever, the new microscope utilizes laser light that diagonally strikes a mirror attached to the top side of the probe; the reflected light is separated into four components by an optical circuit that combines two prisms. The intensities of the four components and their divergence from the central position are picked up by photodetectors (photodiodes).

When an upward force is applied to the probe, for example, the first and second detectors receive intense light, and when the probe is twisted to the right, the first and third detectors receive intense light. Utilizing that phenomenon, NTT researchers calculated on a computer the state of "vertical displacement" and "torsional displacement" from the four components obtained in one measurement, then displayed the results on a VDT.

Because FFMs in the past detected frictional forces by means of an arrangement that did not employ prisms, they could not separately pick up the two amounts of displacement.

Probe Touches With a Very Weak Force, No Damage to Sample Surface

NTT used materials such as optical-disk substrates to evaluate the performance of the new microscope. That resulted in NTT being the first to succeed in accurate observations in cases where the probe was pressed against the sample surface with a force of 20 micronewtons, which damages the surface atoms, as well as in cases where the probe was pressed down with a very weak force of 30 nanonewtons, which does not damage atoms. The microscope can handle a +/- 2 degree range of torsion angle, and measurements of the probe's inclination can be made in increments of about 1/590th of a degree.

Using the new microscope, NTT researchers found that scratches on the surface of an object, which until then were thought to be a big cause of friction, do not have that much of an affect.

"By knowing the distribution pattern of frictional forces, it will be possible to improve upon points we never noticed before. For example, by investigating the state of a magnetic disk's contact with the head, their durability can be increased, and, from the friction between fibers, the pliability of cloth can be controlled," said an NTT spokesman.

[Caption below two photographs] Observations of magnetic head material (aluminum-titanium-carbon-ceramic oxide) in a 3-micron-square range with an atomic force microscope (upper photo) and a frictional force microscope (lower photo). The measured data was then patterned on a computer. In the AFM image showing bumps and depressions on the surface, the brighter parts indicate a greater height above the surface. In the FFM image, the brighter parts indicate greater frictional force. Although there is some sort of relationship between scratches and frictional forces, the distribution of frictional forces is not necessarily consistent with the appearance of bumps and depressions on the surface.

Scanning Probe Microscopes

These are devices that obtain detailed three-dimensional information about an object's surface by scanning a fine probe close to the object's surface. The results of the measurements are then processed on a computer.

The distance between the probe and the object is on the order of one nanometer. There are a few different types of scanning probe microscopes: the scanning tunneling microscope (STM), which utilizes the mutual tunneling current that results when the probe is brought close to the object's surface; the atomic force microscope (AFM), which utilizes the inter-atomic forces acting between the atoms of the probe and the surface; and the magnetic field microscope (MFM), which utilizes the magnetic interaction between the probe and the surface.

Invented in 1981, the STM is used for observing the appearance of the atoms and molecules of a conductor. The AFM is used for observing the appearance of the atoms and molecules of an insulator, and the MFM for observing fine magnetic structures.

Unlike the other probe microscopes, the frictional force microscope (FFM) is special in that its probe touches the sample. If the contact force is strong, however, atoms are damaged and accurate observations cannot be made.

The fact is that, with the FFMs that are already commercialized, the probe applies a force of about 20 micronewtons, which is much larger the destructive limit of 30 nanonewtons.

Scanning-Type Probe Microscopes

	Sample	Means of measurement	Information obtained
Scanning tunneling microscope (STM)	Conductive materials	Tunnel current	The shape of a surface
Atomic force microscope (AFM)	Insulator materials can also be measured	Attractive and repulsive forces between atoms	The shape of a surface
Magnetic force microscope (MFM)	Magnetic substances	Magnetic force	Magnetic [field] distribution
Frictional force microscope (FFM)	—	Frictional force	Distribution of frictional forces: changes in a material, and the shape of a surface

Commentary: Confirmation of Nano-Level Phenomena; Next, Measurements With Absolute Values

Progress is being made in research that involves atomic-level observations of matter. Until now, research has centered around observing shapes of objects' surfaces by means of STMs and AFMs. With the FFM developed by NTT, however, the state of interaction between atoms can be visualized.

Frictional forces so small that they were not considered a problem in the past can now be taken into account, and there appears to be wider possibilities that such capabilities will lead to further advancements in conventional technologies and the emergence of new technologies.

Being able to visualize atomic-level frictional force distribution will lead to evaluating the mechanical characteristics of an object's surface. In extremely advanced fields of research, scientists will be able to experimentally confirm nanometer-level phenomena that have been predicted until now.

For example, when NTT used its FFM to observe the recording surface of an optical disk, factors other than surface scratches that cause a large amount of friction were confirmed. "Moisture in the air forms a film as thick as two nanometers on the disk's surface, and that becomes the greatest cause of friction," says Satoshi Igarashi, chief researcher at the Frontier Domains Research Lab.

Similarly, in the case of contact between a magnetic tape and magnetic head, the lubricant that coats the surfaces becomes a big cause of frictional forces. With this new means of observation, some of what has been common knowledge up to now will be overturned.

However, there is still a problem with the NTT's FFM in that it can only measure relative values now. That is, there is no problem when the distribution of frictional forces is investigated in one sample, but the results of investigating several samples cannot be compared with each other. The measurement of absolute values will probably be brought up as a development issue in the future.

The trial-produced FFM uses the same optical circuitry, which is the basis of the device, as that of an AFM. By just keeping the circuitry to a minimum and adding data-processing software for use on a workstation, one device could be made to function as both an AFM and an FFM. With such an easy equipment investment for that, the frictional force microscope should become an effective means of invigorating research in new domains.

26cm TFT Color Moves Toward A4-Size With Implementation of 70μm Fine Pitch Assembly

94FE0648A Tokyo NIKKEI MICRODEVICES in Japanese May 94 pp 50-55

[Text] The 18-26cm (diagonal) or Types 7-10.4 color LCD panels are used in notebook and sub-notebook style personal computers, key elements in the age of mobile communications. The outer lead connections in the driver LSIs can now be spaced as close as 70μm apart, resulting in new added value. In TFT color panels, one side of the driver is eliminated, making it possible to package a 26cm (Type 10.4) panel in a notebook type computer without changing the external dimensions. Formerly, only a 24cm (Type 9.4) panel could be used. Moreover, the production cost for the Type 10.4 is no different from the Type 9.4. With regard to STN color panels, it is now possible to use two picture drives for 18-20cm (Types 7-8) panels for sub-notebook style computers, thereby adding impetus to the movement toward higher picture quality.

It has become possible to achieve 70μm pitch mounting in the TCP (tape carrier package) of liquid crystal drive LSIs. Narrowing the spacing from the former 90μm pitch accelerates development of products such as one-sided drivers for TFT color and two picture drives for STN color panels. The peripheral technologies pertaining to materials and equipment will be ready by Summer 1994, and mass production of these types of TFT and STN panels could begin as early as Fall 1994 (see Figure 1 and Table 1).

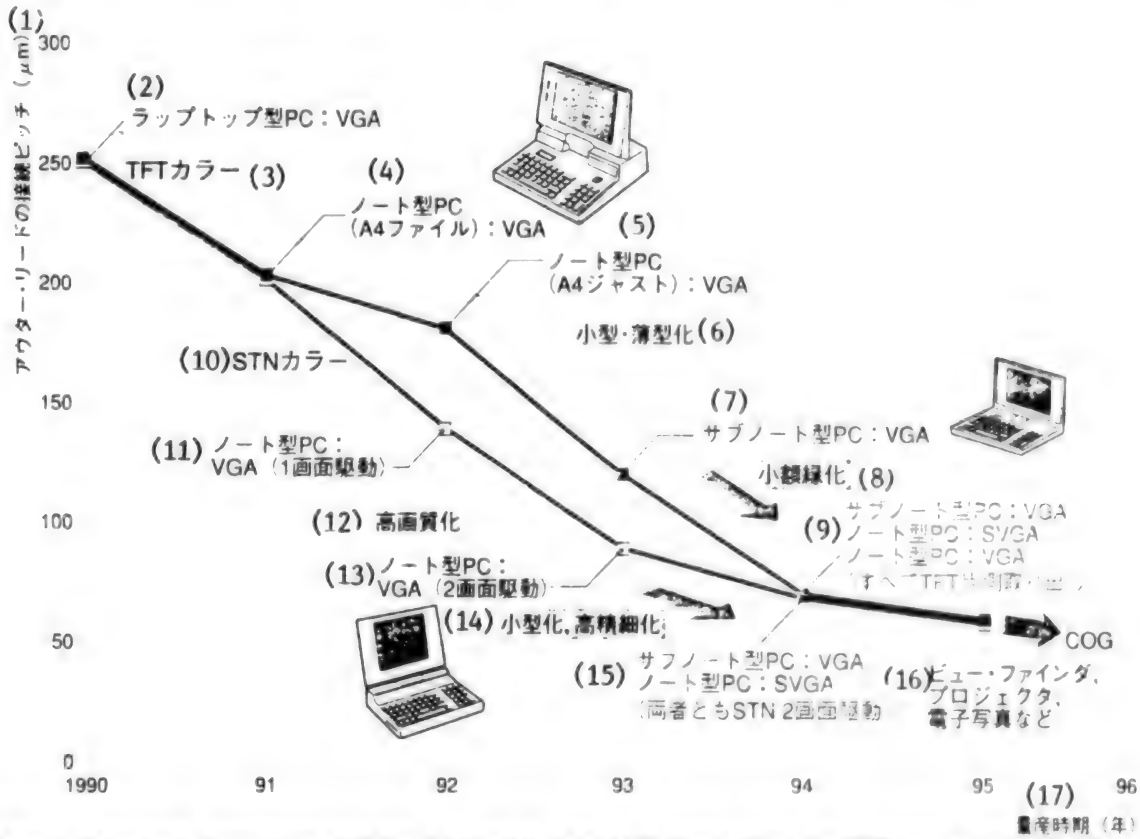


Figure 1. Outer Lead Connections of Driver ICs Used in Color LCD Panels. Since the TFT uses a single side driver, it has the same mounting pitch as the STN two-image drive. 70μm pitch interconnect technology has made it possible to achieve 26cm SVGA and 18cm VGA panels. The next step, which will be 50μm pitch, is not yet foreseeable with the TCP, and there are many who feel that the 50μm pitch and subsequent generations will be limited to special applications. In high density mounting, the progress of STN color is about one year ahead of TFT color. The biggest reason for this is because twice the amount of wiring is required for the drives in the double-screen high picture quality STN color panel.

Key: 1. Outer lead connection pitch (μm); 2. Laptop PC: VGA; 3. TFT color; 4. Notebook type PC (A4 file size): VGA; 5. Notebook type PC (A4 size): VGA; 6. Smaller and thinner; 7. Sub-notebook type PC: VGA; 8. Smaller frame size; 9. Sub-notebook type PC: VGA Notebook type PC: SVGA Notebook type PC: VGA (All single-sided TFT); 10. STN color; 11. Notebook type PC: VGA (single image drive); 12. Higher picture quality; 13. Notebook type PC: VGA (2 screen drive); 14. Smaller, higher precision; 15. Sub-notebook type PC: VGA Notebook type PC: SVGA (both STN double screen drive); 16. Viewfinders, projectors, electronic photography, etc.; 17. Mass production (year)

Table 1. Panel Manufacturing Company Involvement in 70μm Pitch Connection

			Tottori Sanyo Electric	Sharp	Toshiba	Matsushita Electric Industrial Co.	Seiko Epson	Casio Computer
70μm Pitch Outer Lead Connection	Method		TCP	TCP	TCP	TCP	COG	COG
	Technological Improvements	ACF (conductive material)	Dispersion of conductive particles has been improved Adhesive strength has been improved using thinner film	No response	Working toward subminiaturization of conductive particles	Conductive particle diameter is about 5μm transparency achieved at the same time	Connection performance top priority	Conductive particles with insulating cover film adopted Higher density conductive particles used
		TCP Tape (bare chip)	18μm-thick Cu plating used Cu plating surface treatment adtoped	18μm thick Cu plating Sharper tapered cross section used	25μm-thick Cu plating Reinforced with resist coat	18μm-thick Cu plating	Shape and arrangement of bumps determined by heat transfer analysis	Higher pin count achieved by shrinking pads Hardness and height of Au bumps improved
		Mounting equipment	Thermal stability achieved by base heating Preliminary bonding [tact] 3.5 seconds	No response	Pulse heat method adopted, time interval between pressing and heating increased	Tape extension controlled	No response	Picture processing technique improved
Input Connection Process			Leads do not become deformed easily	ACF connection used in some cases	Reinforced with Si resin coating	Reinforced with epoxy resin coating	Connected to FPC by ACF	Low melting point solder, hot air method used
Applications (model, diagonal size, display)		STN, 24 to 26cm, SVGA STN, 18 to 22cm, VGA	TFT, 26cm, VGA	TFT, 26cm, VGA STN, 20 cm, VGA	No response	13cm or less, at present	For TFT, 13cm or less For STN, 13cm or less	
Mass Production		Within 1994	Within 1994	Fall 1994	No response	No response	First half of 1995	
Minimum pitch (mm) now being developed / method			50 to 60 / TCP	50 / TCP	70 / TCP	70 / TCP	50 / COG	50 / COG
	Mass Production Target		Mid 1995	No response	Same as above	No Response	No response	First half of 1996
Notes			Preliminary bonding [tact] 2 seconds targeted for 1995	COG adopted for high reliability at 4cm	Lateral two-piece drive adopted in some cases	YAG laser used for soldering	Bare chip yield is 99 percent	TCP method used for 18cm and larger

In TFT color panels, eliminating one side of the driver makes it possible to accommodate 26cm (Type 10.4) size SVGA (800 x 600 pixel) panels. Outer dimensions in this case are the same as for VGA (640 x 480 pixel) panels of the 24cm (Type 9.4) size. In addition, similar to the 24cm panels, four of the 26cm panels can be taken from a glass substrate 360 x 465mm^2, which is the size used in TFT second phase production lines. For STN color panels, the use of two picture drives for improved picture quality will expand to VGA panels in subnotebook type computers, and to SVGA panels in notebook-type computers.

To achieve the 70μm fine pitch connections, advancements have been made with regard to materials such as the anisotropic conductive film (ACF) and tape materials used in tape carrier packages, as well as the technology related to the mounting equipment.

(1) In the anisotropic conductive film, conductive particles have been insulated, and resistance to peeling has been improved.

(2) For TCP tape, copper plating has been made thinner and measures have been taken to prevent disconnections associated with lower film strength.

(3) With regard to mounting equipment, expansion caused by non-uniform positioning during temporary bonding and by heat expansion of TCP tape has been controlled. Overall bonding shift has been reduced from the former +/- 15μm to +/- 10μm and less.

The chip on glass (COG) method, which is oriented toward high density mounting, is beginning to be adopted in panels that are 13cm (Type 5) and smaller in order to lower the cost. In small panels, the frame area around the display section is also becoming smaller, and thickness is equal to that achieved using the slim TCP method (see Figure 2).

方式 (1)	COG	(2) スリム TCP	(3) 折り曲げ TCP
(4) モジュール形状			
対角 25 cm 級で小額縁化	△	△	
対角 25 cm 級で薄型化	○	○	×
(5) ガラス基板の小型化			
[25 cm 級製造時の周辺部]	×	○	
(6) モジュールの低コスト化			
対角 13 cm 以下に対して	○	△	×
対角 18 cm 以上に対して	×	○	△

(7) ○：有利，△：やや有利，×：不利

Figure 2. Advantages and Disadvantages of Each Mounting Method. The chief reasons why COG is not suited for panels larger than 18cm (Type 7) are because: (1) As the number of driver LSIs increases, bare chips cannot be sufficiently guaranteed under current conditions, so mounting yield drops sharply; and (2) An additional area of substrate is needed where the chip is situated on the glass edge, making it difficult to obtain several chips per substrate, etc.

Key: 1. Method; 2. Slim TCP; 3. Folded TCP; 4. Module shape; Smaller frame possible for 25cm panels; Thinner size possible for 25cm panels; 5. Smaller glass substrate [Peripheral area when producing 25cm panel]; 6. Lower cost module; For 13cm and smaller panels; For 18cm and larger panels; 7. Circle: Suitable; Triangle: Somewhat suitable; X: Not suitable

Type 10.4 TFT Panels for A4 Notebook Computers

The achievement of 70μm pitch connection brings about design and production advantages for the TFT panel and design advantages for the STN panel.

With regard to the design of the TFT panel, the source/driver and signal bus connections have formerly been arranged on the upper and lower sides of the screen. This can now be changed to only one side. When these connections are made on both sides, a comb-type connection is used, skipping every other "tooth" of the comb. However, when arranged on only one side, each tooth of the comb is used, so the mounting pitch is halved.

Since the mounting area is on only one side, the frame around the display area can be decreased in size. This makes it possible to package a 26cm VGA display and even an SVGA display within the same external dimensions of a conventional 24cm panel. In Fall 1994, mass production of a one-sided VGA panel will begin first with the 26cm size.

With regard to the production aspect of TFT panels, it is now possible to obtain four 26cm panels from a 360 x 465mm^2 glass substrate. This is because the driver is arranged on one side, resulting in a decreased wiring area on the glass substrate.

In the design of the STN panel, the use of a double screen drive can now be used for higher precision panels with better picture quality. With the 70μm pitch connections, the double-screen drive can now be used for 18-20cm (Type 7-8) sub-notebook computer VGA displays, and also for 26cm notebook computer SVGA displays. The VGA for sub-notebook computer displays will first appear in Fall 1994.

STN Color Panel Producers Promote 70μm Pitch Connection

Tottori Sanyo Electric, Sharp, Toshiba, and Hitachi Ltd. are actively promoting the 70μm pitch connection. All four companies are already mass producing STN color double-screen drives for 24 to 26cm VGA panels, with 90μm pitch connections. With the exception of Tottori Sanyo, the companies will also move toward single-sided TFT panels.

Tottori Sanyo and Hitachi have taken the lead in high-density mounting technology. By starting early with the 70μm pitch connection, Tottori Sanyo has expanded its line of high quality products having double-screen drives, thus placing STN panel manufacturers in a strong position against the TFT panel manufacturing companies (see Figure 3).

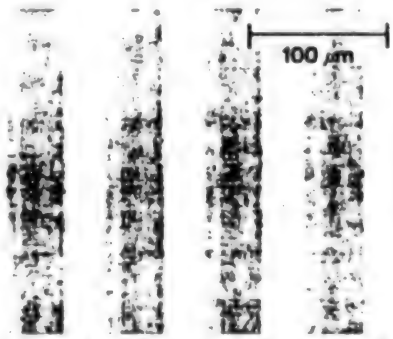


Figure 3. Example of 70μm Pitch Connection. Tottori Sanyo Electric; mass production technology on the horizon

Hitachi established 100μm pitch technology in 1992 for its 28cm (Type 11) 1120 x 780 pixel TFT panel used in portable work stations, and claims that an extension of that technology has led to the 60μm pitch mounting technique.

Toshiba's initial efforts to develop a 25cm (Type 10.2) panel (four per substrate) were eventually abandoned, according to its LCD business group. This is because other companies were able to achieve a 26cm panel with connections on one side, and the major personal computer manufacturing companies chose the 26cm version, which sold for the same price.

Although specific details are not known, Sharp has already begun shipping samples of a 26cm one-side connection panel, which has the same external dimensions as its 21cm (Type 8.4) panel, and module height of 179.4mm.

ACF Used for 50μm Pitch

To achieve 70μm pitch mounting, the material and mounting technology for ACF and TCP were significantly improved.

For anisotropic conductive film, technology has advanced one generation ahead of the actual mounting pitch used, including the margin required for mass production (see Figure 4). Hitachi Chemical and Sony Chemical have both developed anisotropic conductive film which can be used in 50μm pitch mounting, and have adopted it for use in 70μm pitch mounting at the mass production level.

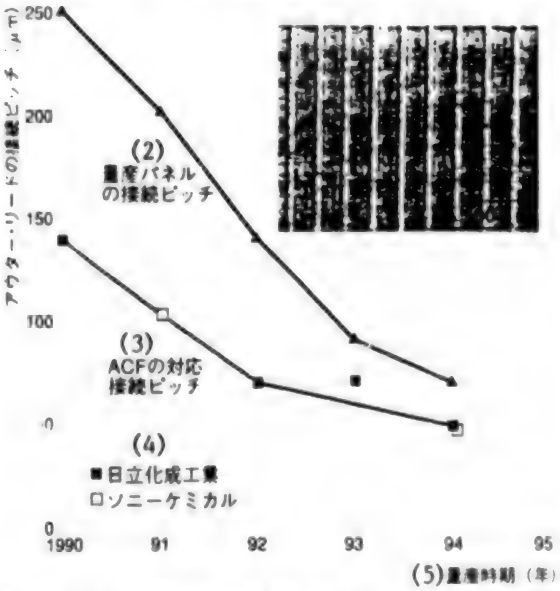


Figure 4. Connection Pitches for ACF. ACF is one generation ahead of actual connection pitch. The photograph shows a Sony Chemical prototype.

Key: 1. Outer lead connection pitch (μm); 2. Connection pitches of mass produced panels; 3. Connection pitches for ACF; 4. Black square: Hitachi Chemical Industrial Co. White square: Sony Chemical; 5. Year of mass production.

In narrow pitch mounting, it is important to somehow ensure that there is insulation between the electrode pads. To do this, Hitachi Chemical Industrial Co. focused efforts on the dispersion characteristic of each particle. On the other hand, Sony Chemical uses insulation film-covered particles developed for COG, and this has also been adopted for TCP.

Since the contact surface of the electrode is smaller for narrow pitch connection the peeling resistance of ACF greatly affects the reliability of the connection, according to Tottori Sanyo's LCD group. For 70μm pitch, it is necessary to achieve a uniform thickness of 18μm, where resistance to peeling is at its peak (see Figure 5).

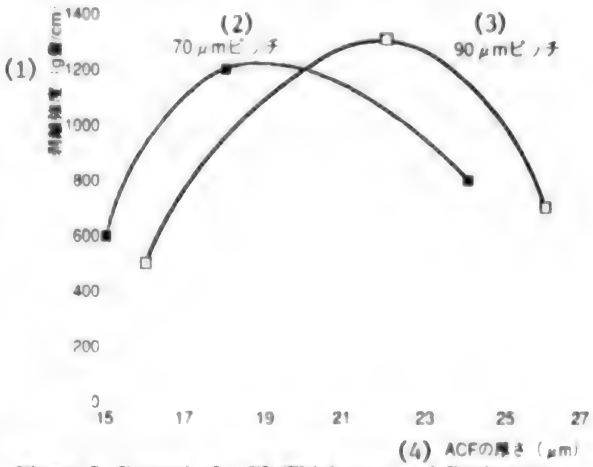


Figure 5. Control of ACF Thickness and Resistance to Peeling. When ACF is too thin, peeling occurs on the TCP side; when it is too thick, peeling occurs on the glass side. Resistance to peeling within the ACF is best when thickness is optimum. When pitch is narrow, it is particularly important to control thickness to peak condition. Data provided by Tottori Sanyo Electric.

Key: 1. Peeling resistance (grams weight/cm); 2. 70μm pitch; 3. 90μm pitch; 4. ACF thickness (μm).

To form wiring at 70μm pitch, the thickness of copper plating on TCP tape has been changed from 25μm to 18μm, and samples have begun shipping.

The drop in strength associated with the use of thinner copper plating is a problem. The problem is not on the output side which is spaced at 70μm pitch, but on the input side, where copper wire is exposed and is especially fragile during soldering to the printed circuit board. Toshiba and Matsushita Electric Industrial Co. reinforce the connection area with resin, Japan IBM adds solder to the periphery for reinforcement, and Sharp deals with this problem by adopting an ACF connection method.

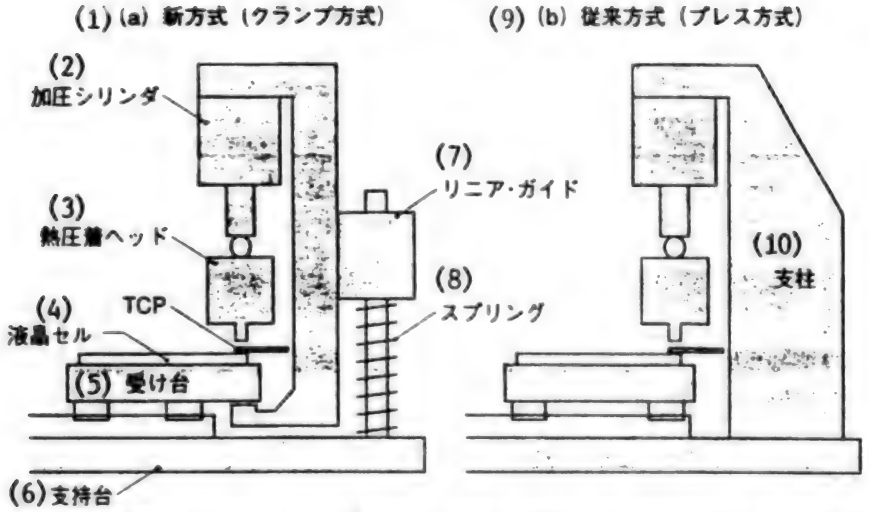


Figure 6. Example of New Design Used in Main Bonder. Use of a clamp-type pressurizer prevents bonding force from transferring to the support base. In the former type, the support base was directly connected and became warped.

Key: 1. (a) New method (clamp type); 2. Pressure cylinder; 3. Thermocompression head; 4. Liquid crystal cell; 5. Holder; 6. Support base; 7. Linear guide; 8. Spring; 9. (b) Former method (press type); 10. Support column.

Mounting equipment which keeps the pattern shift during bonding to +/- 10μm or less has been developed. In particular, thermoexpansion is suppressed during main bonding (see Figure 6 and Table 2).

Table 2. Equipment fo 70μm Pitch Applications

	Sony	Hitachi Electronic Engineering	Kyushu Matsushita Electric	Matsushita Electric Industrial Co.	Toshiba	Osaki Engineering
Features	Clamp-type main compression adopted For one-sided applications; equipment length 2.1m	High-speed/ high-precision image recognition Also can be used for thin film cells	Feedback during preliminary compression Can be used for CIM applications Model can be changed in short time	TCP taping supplied Does not require clean room Can be used for both individual and continuous production	Relative position of one field of vision can be recog-nized	Model can be easily changed Easily maintained Freely used in production lines
Corresponding cell dimen-sions (diagonal)(cm)	8 to 26	10 to 41	18 to 53	10 to 38	20 to 36	8 to 38
Preliminary bonding time (seconds)	4.5	3.8	2.5 to 4	3.8	4.5	4
Preliminary bonding shift [3δ] (μm)	+/- 7	+/- 4	+/- 8	+/- 9	+/- 7	+/- 5
Main bonding shift [3δ] (μm)	+/- 4	+/- 4	+/- 6	max 10	+/- 5	+/- 10
Type of head for main bonding	Multiple type	General type	Multiple, general	General	Multiple, general	Multiple, general
Head replacement time (minutes)	15	5	15	1	30	10
Dust control measures	Dust-proof components in moving part sections, metal particle suction around die	Clean air module, metal particle suction	Dust collector used in TCP punching area, direct transport by linear motor	Clean air module, direct adsorber transport	Adsorber transport at cell bottom, metal particle suction around die	Clean air module, metal particle suction around die, electrostatic blow removal
Price ¥	35,000,000	85,000,000	120,000,000 to 150,000,000	60,000,000 to 90,000,000	Not determined	About 60,000,000

COG Method Used for Smaller Panels

In terms of cost, the COG will likely become more widely used in 13cm (Type 5) panels.

In February 1993, Seiko Epson began supplying MIM color panels which use COG driver mounting for use in camcorders with LCD monitors. Seiko Epson design engineers report that the panels are thinner and the frame is also smaller than those produced by competitors using the folded TCP design (see Figure 7 and Table 3).

Casio Computer began using the COG method in all of its TFT liquid crystal production in April 1994 (see Figure 8). This is because fewer parts are required for 13cm size and smaller, and cost is lower than TCP (see Table 4).

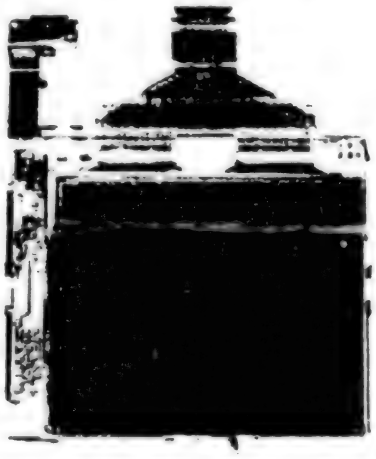


Figure 7. Type 2.5 MIM Panel Module. Seiko Epson supplies these for use in camcorders with Fuji Film LCD monitors. Thinner and smaller size was achieved using COG method with AGF connection. The MIM uses a lateral device.

Table 3. TFT and MIM Module Dimensions

The MIM module is thin. Specifications for Sharp were estimated by the editors. Both types are used in camcorders with LCD displays

Method		TFT	MIM
Diagonal Dimension (cm) [type]		7.5 [3]	6.3 [2.5]
Number of Dots		322 x 235	312 x 230
Dot pitch (μm^2)		190 x 188	162 x 168
Type of Drived Connection Used		Folded TCP	COG
	Connection pitch (μm)	180	80
	Output	One side	One side
Frame Dimensions	Upper width (mm)	10.2	12
	Lower width (mm)	10.3	5.2
Thickness	[with backlight] (mm)	11.1	8.6
	[with signal processing board] (mm)	16.6	12.9

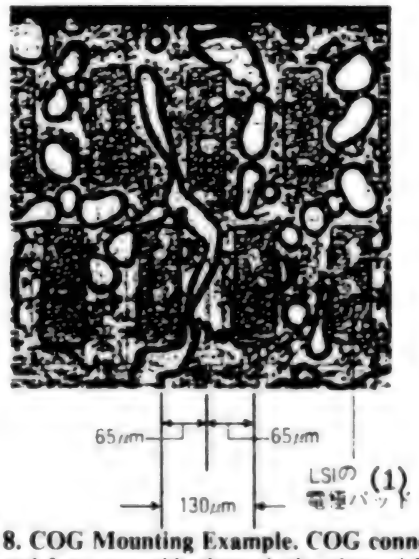


Figure 8. COG Mounting Example. COG connection area viewed from rear side through the glass. ACF was used for connection, with insulating film coated particles. Pad pitch of the driver LSI is in zigzag arrangement. Example is provided by Casio Computer.

Key: 1. LSI electrode pad

Table 4. Cost Comparison for COG and TCP

Casio test results show that COG costs less overall for 13cm (Type 5) and smaller panels

Method		COG	TCP
Liquid crystal cell		X	O
Driver		O	X
Printed circuit board		O	X
Mounting Process		O	Δ
Inspection/ Correction	[Type 7 and larger]	X	O
	[Type 5 and smaller]	Δ	O

TFT One-Sided Driver Method Implemented; Smaller Module and 4 Panels per Substrate Achieved

26cm (Type 10.4) TFT modules with one-sided drivers will begin coming out in Fall 1994. The new modules will have the same external dimensions as former 21cm (Type 8.4) and 24cm (Type 9.4) modules.

This addresses the strong demand from several U.S. computer manufacturers who would like to put the largest screen possible within a frame having the external dimensions of the conventional "exact A4" size. The suggestion made by some panel manufacturers for a 26cm panel with driver on one side has had far-reaching effects. From the production apsect also, there is the advantage that four panels can be produced from a 360 x 465mm^2 substrate (see Figure A).

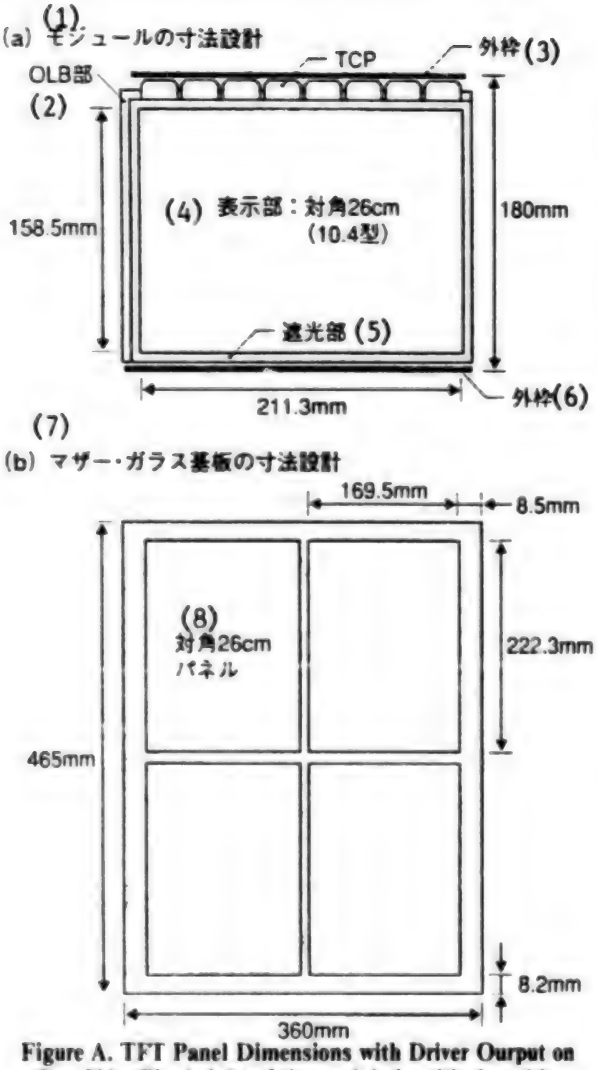


Figure A. TFT Panel Dimensions with Driver Ourput on One Side. The height of the module is critical; and by arranging the driver output on one side, height is about 180mm (a), which is the same as for 24cm (Type 9.4) panels which have drivers on both sides. The outer lead connection area is half that used in the double-sided design; since only about 3mm is needed, four 26cm (Type 10.4) panels can be produced from a 360 x 465mm² substrate (b). Hoshiden, which is switching to color panels, and Advanced Display (ADI) which is aggressively developing panels for office products, will adopt the single-sided driver design.

Key: 1. (a) Module Dimensions; 2. OLD section; 3. Outer frame; 4. Display area: 26cm (diagonal) (Type 10.4); 5. Light shield; 6. Outer frame; 7. (b) Mother Glass Substrate Dimensions; 8. 26cm (diagonal) panel

However, the one-sided driver type is not being welcomed by all of the panel manufacturing companies.

First of all, there are limitations to the drive method. For example, in order to use the inverted drive method for each dot, as in NEC's case, it is necessary to redesign the driver. This is because double-sided drivers were divided into even and odd drives, but there is only one driver in the single-sided method. There is also the problem that most of the technical progress achieved for the double-side drive method will become obsolete (according to major LCD panel manufacturers).

There is also the problem that the frequency of the input signal will double. If the maximum frequency on the driver side is not sufficient, it will become necessary to divide the screen into left and right sides, and drive them simultaneously; so the signal bus will have to be halved. For such cases, the controller will have to be redesigned. In addition, due to the higher frequency of the driver, electromagnetic noise control will be essential, and immediate solutions are needed.

Toshiba Releases for the First Time Cumulative Failure Rate of NAND-Type Flash Memory After Data Rewrite

94FE0658 Tokyo NIKKEI MICRODEVICES in Japanese May 94 p 92

[Text] **Toshiba has announced for the first time the cumulative failure rate of a flash memory after data has been rewritten. The cumulative failure rate measured in block units after rewriting data 250,000 times in a NAND type chip is 0.017 percent. A card which uses this chip has been developed together with the IBM Corporation of the United States, and IBM has formally announced the release of the new card product.**

In January 1994, U.S. newspapers reported that there was a basic problem with Toshiba's NAND-type memory, and that shipment of the product would be delayed due to design changes. In an earlier example, Intel Corp. of the United States had announced the mass production of an 8M flash memory, but was unable to ship the product. For these reasons, many customers felt that production would be more difficult than expected.

Toshiba countered that the newspaper report was unfounded. However, it did acknowledge that according to a survey made by Nikkei Microdevices in 1993, there was a problem with reliability of the product. Toshiba has now solved the problem, and is announcing reliability data such as the failure rate after data rewrite. This information has not been released by other manufacturers of flash memories to date. To boost customers' confidence in the product, Toshiba has also clarified details regarding the production schedule.

Guaranteed Rewrite Operations Changed to 250,000 Times

The number of data rewrite operations is a major indicator of reliability, and Toshiba is guaranteeing 250,000 operations, which essentially corresponds to an operational time of 10 years. To determine the guaranteed number of operations, various benchmark tests were performed, and it was concluded that 250,000 times

would be sufficient even for education-related equipment where many rewrites are needed.

Based on this number, Toshiba has released the three largest indicators of reliability:

(1) The cumulative failure rate after rewrite;

(2) The cumulative failure rate caused by read-out disturbance following rewrite;

(3) The cumulative failure rate during data storage.

In addition,

(4) The frequency of excess data writing, which is peculiar to NAND-type chips, was announced.

Data is current as of April 15, 1994.

Item (1) was measured in block units. A 15M chip is comprised of 512 blocks. When 514 chips were tested by rewriting data 250,000 times at 5.5V and 25°C, 40 blocks failed, for a cumulative failure rate of 0.017 percent. The failure rate when tested at 5.5V and 85°C was 0.028 percent, which is still within the valid range for memory chips. Competing manufacturers concur that there will likely be no problem in suing the product as a replacement for magnetic disks.

Item (2) above was measured at 5.5V and 25°C. After rewriting data 250,000 times and then reading the data 10,000,000 times (which are impossible conditions to begin with according to Toshiba), a defective bit was not found. Item (3) was measured for 1,000 hours at 25°C, 85°C, and 150°C. Out of 151 chips at 150°C (which is beyond the guaranteed range), only two chips failed. Item (4) was measured for up to 100,000 rewrite operations. No failure was observed at 4.5V/25°C, 5.5V/25°C, and 5.5V/85°C.

Toshiba plans to enter into production of a 16M bit chip carrying this type of guarantee by the end of 1994, at a rate of at least 500,000 chips per month. Current production is about 100,000 chips per month.

IBM has announced a card which uses the new chip.

Utility Companies Report Severe Accident Management Measures to MITI

94FE0769A Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 7 Apr 94 p 2

[Text] On March 31, the MITI received a report on accident management measures from the nine utility companies having nuclear power generation and the Japan Atomic Power Company.

In July 1992, the MITI had requested the pertinent utility companies to voluntarily arrange their accident management measures. This was a summary of measures which would, in an unlikely event, prevent severe accidents (severe accidents which are beyond what may be anticipated due to the design of a reactor) by implementing, for the first time in Japan, at each plant the probability safety assessment (PSA) which has been developed as a new safety assessment method and is available to be utilized.

As expressed by Makoto Boshima, chief of Safety Analysis Investigation Section, MITI Nuclear Power Generation Safety Planning Review Division, "we are hoping nuclear power generation will move from something that is safe to something that gives peace of mind."

PSA targeted 51 commercial plants either in operation or under construction in 1992. As a result, the severe accident probability for the existing reactors became less than once in a million years, and less than once in 10 million years for the ABWR of Kashiwazaki Kariwa No. 6 and No. 7. The figures, less than one in 10,000 years at the existing reactors and less than one in 100,000 years at the newly constructed reactors, which sufficiently clear the IAEA's safety targets, once again highlighted the fact that the occurrence of severe accidents at our nation's nuclear power generation stations is almost inconceivable.

Nevertheless, with the progress of the development of a new safety assessment method called probability safety assessment (PSA), there are cases wherein necessary measures are taken by way of the implementation of PSA at individual plants overseas as well, which led Japan to conduct PSA at individual plants to take such safety measures.

The necessary measures are taken fundamentally from the three standpoints of: 1) cooling the reactor; 2) sealing the radioactive materials; and 3) safely shutting down the reactor, depending on the type of each of the PWR and BWR reactors and the current situation at each individual plant.

The major measures include inserting the control rod through an alternate system when having failed to insert it, or by proceeding with an emergency cooling, in order to enhance the function to stop the reactor.

And as for the measure to cool the reactor interior, the installation of separate pipes are being considered to douse with water, in the case of B, the core and the reactor containment from the water storage tank by means of the extinguisher pump even when the emergency core cooling system breaks down, and to supply water for the fuel pool water, in the case of P, even when the water source in the ECCS is gone.

In containing radioactive materials, a system to let the expanded vapor in a high temperature escape through a water filter (water filter venting), in the case of B, even when, in an unlikely event, the facility to remove heat from the reactor containment breaks down, and a system to lower the pressure by cooling the hot vapor by utilizing the reactor containment's radiator for cooling or an installation of a hydrogen combustion device to prevent the damage to the reactor containment by artificially burning up the hydrogen gas being generated, are being considered. Though the filter vent releases the radioactive materials into the atmosphere under the most severe condition under which the reactor core may be damaged, the water filter is understood to be able to lower the amount of the radioactive materials being released into the atmosphere to one thousandth of it. Further, the hydrogen combustion device will be installed with Oi numbers 1 and 2 equipped with an ice-condenser type reactor containment. We expect that these measures do not require a request for installation modification permit. Each utility plans to complete the measures by the year 2000.

The MITI will evaluate the study report for each unit, and will report the result to the Nuclear Safety Commission this summer.

Increasing Degree of Safety and Reliability Anticipated: A Comment by the NSC

On March 31, the Nuclear Safety Commission issued a comment on the study result on the accident management submitted by each utility to the MITI by saying, "we understand the Administrative Agency will conduct a necessary study. We anticipate this will result in further improvement on the safety of the reactor facility and more trust on the part of the public in the safety of nuclear power."

While the commission states, "the safety of the reactor is as such that the possibility of severe accidents happening is so minute to the extent that they can be considered from the engineering standpoint as non-occurring on account of the strict safety measures based on the idea of multiple protection," the present arrangement of the accident management stands as a measure to further decrease such low a risk.

JAERI Cooperates With U.S. On Advanced PWR Safety Test

94FE0769B Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 21 Apr 94 p 2

[Text] The Japan Atomic Energy Research Institute announced on the 15th that they began experimental research, the "ROSA-AP600 Project," on the safety of the light water reactor, AP600, equipped with a passive

safety mechanism, being developed by the U.S. as a reactor of the next generation's type.

This project will be implemented over the duration of about a year in cooperation with the U.S. Nuclear Regulatory Commission (NRC) by utilizing the JAERI's large non-stationary testing facility (LSTF), the result of which will constitute a basic document for the safety review of this reactor by the NRC. It will be the first time that JAERI will play the central role for the safety inspection of the U.S. light water reactor, and the fact that our nation's research on safety is at the highest international level should be noteworthy.

The AP600 reactor is a PWR with the power output of 600,000kW equipped with a passive safety which requires no power source in the event of an accident, and being developed by companies such as Westinghouse Corp. with the backing of the U.S. Department of Energy (DOE). It is considered one of the front runners for the next generation's reactor.

The first test was conducted on the 14th. It was on the operational status for the passive ECCS by drilling a hole of 6mm in diameter in the mock reactor pipe (equivalent to a hole of 2.5 cm in diameter in the actual facility). The pressure inside the facility decreased to close to the atmospheric pressure in about two hours following the start of the accident (the start of the test) and stabilized without the operator using the equipment. Further, the cooling of the core was constantly maintained with ample room to spare, and thus it was viewed as a desired test result.

STA's Omega Program: PNC To Develop Large Current Electron Accelerator

94FE0769C Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 28 Apr 94 p 2

[Text] While the "Omega Project," research for separating high-level radioactive wastes produced by reprocessing spent fuel into a number of groups by the nuclide and effectively utilizing them, has been carried out by various research organizations with the Science and Technology Agency at the core, Power Reactor and Nuclear Fuel Development Corporation plans to build, as part of that effort, a large current electron accelerator at the Oarai Engineering Center in Ibaraki Prefecture with the total construction cost of about ¥4.8 billion for research on annihilation disposal. The start of the beam test is scheduled at the beginning of 1997.

In 1993, PRNFDC began a partial production of accelerator element devices such as electron beam accelerator system, and in 1994, it will begin its production of ancillary facilities such as accelerator cooling system.

Among high-level radioactive wastes, transuranic (TRU) nuclides such as neptunium and americium and fission products (FP) with a relatively long half-life such as strontium and cesium, rhodium being a useful metal, platinum group such as palladium are included.

While PRNFDC considers it appropriate to utilize an accelerator to annihilate TRU nuclides, they are pursuing the possibility of annihilation disposal by an electron beam accelerator since it is difficult to annihilate long-life fission products with an ordinary reactor.

The annihilation disposal by an electron beam accelerator aims at decreasing the radioactivity volume of the high-level radioactive wastes as a whole by colliding the high-speed electron beam obtained by the accelerator directly into the target nuclide or the target such as tungsten and converting it into a short-life or stable nuclide which would not emit radioactive rays by utilizing the gamma-ray/neutron reaction by the gamma ray which is generated.

While the possibility of realization in the application of the accelerator has increased on account of the recent progress in accelerator technology and a great stride in high-tech technology, an electron beam accelerator with a large current from some hundred mA to several A, which currently does not exist, is required to annihilate a long-life nuclide. In terms of large current, problems are the prevention of the electron beam dispersion and the heat resistance and removal of the accelerating tube.

PRNFDC has so far experimentally manufactured devices that are the main constituent elements such as the accelerating tube which loads the electron onto the microwave and accelerates it to a high speed, and the klystron which supplies the microwave, and has, in cooperation with the High Energy Physics Laboratory, conducted, since 1988, large power testing to verify their performance.

As a result, they have been able to steadily generate radio frequency power up to 800 kW without the accelerating tube causing discharge or heat deformation. As for the power resistance of the output window which becomes an issue with the klystron's large output, the development of a window able to withstand the world's largest power at 1.7 MW at the maximum in one of the L band frequency ranges, which is greater than the development target, has been successful in an experimental product by the formation optimization design around the window.

With these accomplishments, while continuing with the production of the accelerator's element devices, they will commence the production of exhaust gas processing facility, which is an ancillary facility for the accelerator's constituent devices, radiation management facility, accelerator cooling system, and the like.

Japan Agrees to Provide Preferential Exams to International Applications

94FE0817A Tokyo NIHON KEIZAI SHIMBUN in Japanese 29 Jun 94 p 5

[Text] On 28 June it was announced that parties involved in the Japan-U.S. Comprehensive Economic Council's negotiations on intellectual property rights agreed that 1) the U.S. would introduce a patent re-examination system and a system for making public the contents of patent applications, and that 2) Japan would give preferential examinations to inventions for which international applications are submitted. Both the Japanese and U.S. improvement measures will bring the two countries' patent systems into accord and will help prevent international patent disputes.

The contents of the agreement are expected to be incorporated into the joint statement of the meeting of the Japanese and U.S. heads of state that will be held prior to the Naples Summit in July.

In the patent re-examination system that the U.S. will introduce, an already patented invention will be re-examined if a third party raises an objection to the patent. For example, the new system would allow a Japanese firm suspected of infringing upon the patent held by a U.S. firm to request a re-examination of the patent. The extent of the U.S. firm's patent would then be defined in the re-examination so that a judgment can be made as to whether or not the Japanese firm infringed upon the patent.

There are more than a few cases in the U.S. of foreign patent infringement charges developing into litigation problems and Japanese firms end up settling out of court for large sums of money. If the U.S. introduces this system, such problems could be solved through government procedures, and that would help lighten the burdens of Japanese firms unaccustomed to U.S. litigation.

The system for making public the contents of patent applications will help solve the problem of firms being sued for unknowingly using technology that suddenly becomes patented one day after many years of not being made public while the patent application is made and the invention or idea is examined. Japanese industry has strongly sought after the introduction of these two systems. The U.S. Patent Office's course is to appeal to Congress to approve the measure [to introduce the two systems] by September.

Japan will improve its management of the examination system so that preferential examinations will be provided for inventions or ideas for which a patent application is made by a person outside of Japan. The U.S. has been asking Japan to shorten the examination period.

The patent problem is an important topic of the negotiations on intellectual property rights, which is one of the five additional areas following the three priority areas—automobiles, automotive parts, and insurance—of the Comprehensive Economic Council. Although the negotiations resumed on June 7 and 8, no agreement was reached. Later, Director-Generals Aso and Layman of the Japanese and U.S. Patent Offices continued discussing the issue and managed to reach an agreement. With that agreement, the focus of the problem between Japan and the U.S. on uniformity of patent systems will shift to the U.S.'s "shifting away from the doctrine of 'first to apply'" and to Japan's "shortening of its examination period."

STA Announces Basic Policy for FY95

94FE0817B Tokyo NIKKAN KOGYO SHIMBUN in Japanese 20 Jul 94 p 2

[Text] By 18 July the Science and Technology Agecy (STA) had decided upon a four-pronged basic policy for FY95 aimed at upgrading the research information base, securing and fostering scientific and technical personnel, reviving and expanding the basic research system, and expanding the science and technology especially geared toward the people. An important theme in connection with upgrading the research information base will be the promotion of computational science and technology. The STA will establish two new programs: "The Parallel Procesing Technology R&D Project" and "The Application Software Development System" (both are provisional names). In connection with fostering scientific and technical personnel, the agency will set up science and technology camps that employ the facilities of special corporations under its umbrella. As measures against the distancing of youth from science and technology, the goals are to set up science halls and to deepen children's interest in science and technology. In expanding the science and technology especially geared toward the people, the STA will pour its strength into the R&D of technology for coping with an aged society. The STA's estimated FY95 budget request will also follow along the lines of this basic policy.

The multimedia and networking wave in information and communications, which originated in the "information highway" concept of the U.S., is surging upon Japan. Yet Japan lags considerably behind the U.S. in the development of application software and in networking.

Based on that recognition, as its measure for upgrading the research information base, the STA will promote research based on the furtherance of computational science and technology (numerical simulation). Examples of such research are efforts to elucidate the phenomenon and mechanisms of high-temperature superconductivity, and research to understand global-scale marine and atmospheric circulation systems. For that purpose the STA will institute "The Parallel Processing Technology R&D Project," and "The Application Software Development System" that will expand those results into the form of general-purpose software.

In facilitating the distribution of scientific and technical information, the STA will further improve and expand the "Research Information Network" it started in FY94. At the same time the agency will work toward speeding up the network and building a system that can quickly exchange large volumes of information. From the viewpoint of international cooperation, the STA will also expand its involvement in the work of constructing and providing access to a database for human genome analysis.

In connection with securing and fostering scientific and technical personnel, the STA will set up science halls for the purpose of deepening young people's interest in science and technology. In particular, the agency will set up a multidisciplinary science and technology zone, called "Play, Know, Love" (provisional name) that will function as a place for both play and contact. In order to present the roles that science and technology have played in human advancement, the STA will also investigate the promotion of research in the history of science, the preservation of historical relics, and exhibition enterprises. And, in order to have children actually see the activities of scientists and researchers, special corporations under the STA will be the stage for a "Science Camps" program. The STA will also sponsor gatherings, modelled on the Christmas lectures of the British Royal Academic Society, where the Japanese people can interact with researchers and scientists.

As for the STA's promotion of basic research, because a considerable number of the ERATO research themes are covered there, the agency will radically reorganize the Basic Research Promotion System, and will study a new system aimed at providing lavish research expenses for uncovering completely unexplored areas. In its promotion of science and technology especially geared toward the people, the STA will establish the "New System for Promoting Basic Research for Society," and will steer R&D that takes into account the needs of the people. Some of the goals of that are the realization of information systems for a society with many elderly people, the realization of energy utilization systems that are kind to the environment, and the creation of revolutionary heat-storing materials.

MITI Establishes Material Industry Forum With Six Major Companies

94FE0817C Tokyo NIKKAN KOGYO SHIMBUN in Japanese 20 Jul 94 p 2

[Text] MITI established the "Basic Material Industry Forum" to deal with common issues of the material industry such as strengthening international competitive power, maintaining and equipping a technology development base, and environmental preservation measures. The forum consists of the presidents of six major companies from the iron and steel, nonferrous metals, chemicals, pulp and paper, cement and plate glass industries, and the heads of the Basic Industries Bureau and the Consumer Goods Industries Bureau. The first meeting will be held on 26 June. The forum will discuss the state of the material industry in the future—how production and supply systems should be strengthened by means of corporate solidarity, and measures that will make the best use of the material industry's own unique production technology in dealing with rubbish and soil pollution problems. With the growing appreciation of the yen and the drop in domestic demand, the material industry's share of all industries' production is seen as declining. Through environmental measures and the like, the material industry will try to survive by bringing out a different robust strength and new social development industry that is connected to lifestyles of the people.

The members taking part in the Material Industry Forum are Takashi Imai, president of Nippon Steel Corp.; Akihiko Shinozaki, president of Sumitomo Metal Mining Co., Ltd.; Hiromichi Sedani, president of Asahi Glass Co., Ltd.; Shoichi Tachimoto, president of Sumitomo Cement Co., Ltd.; Masahiko Furukawa, president of Mitsubishi Chemical Industries, Ltd.; and Takeshiro Mizushima, president of Nippon Paper Ltd. In the monthly meetings the members will freely discuss industrial vision and environmental policy issues. The forum will occasionally submit proposals and requests to the government but will not compile reports because it is not an advisory organ. The establishment of an organization that straddles two bureaus within the ministry is rare.

To strengthen the competitiveness of companies within the material industry, the forum will take a new look at mergers, continuous production, and tranfers of non-profitable departments. It will also re-examine the excessive numbers of product types, quality, and business conventions. Then, from the other aspect of creating demand, e.g., new enterprises and product development [illegible] elimination of regulations, the forum will find the problem points and search out the best ways to solve the problems.

As for environmental measures, the forum will discuss measures for building comprehensive systems that utilize the material industry's production technologies for dealing with 1) very high temperatures, 2) large-volume production, and 3) rapid chemical reactions for application to [illegible] processing technology, among other applications, and measures for energy conservation and recycling. Concrete examples are making the best use of the cement industry's calcination technology to convert sewage pollution into raw materials for cement, and utilizing the steel industry's high-temperature processing technology to convert urban trash into artificial bone materials.

As for maintaining and maintaining the base for promoting technology development, the forum's policy is to discuss issues such as the necessity of a database with information about the lifetimes of materials and safety tests and evaluations of chemical products, and an information network that would link corporate laboratories with national laboratories and testing and development organizations such as the Protein Engineering Laboratory.

MITI To Reinforce R&D to Separate CO_2 With a Ceramic Film

94FE0817D Tokyo KAGAKU KOGYO NIPPO in Japanese 10 Jun 94 p 1

[Text] MITI will begin the actual R&D of technology for high-temperature separation, recovery, and re-use of CO_2. The aim is to develop a system that uses a ceramic film to separate hot CO_2 from the exhaust gas expelled from steel mills and electric power plants. The system will utilize the high temperature of the CO_2 to reduce it to CO and then re-use the CO. MITI also plans to establish technology for recycling CO into useful substances such as formic acid and calcium carbonate.

MITI has been conducting a feasibility study for the past two years, but the actual R&D will begin this fiscal year. Ten companies, including Sumitomo Electric and Asahi Glass, will particpate in the R&D, which will continue until FY2001.

This project is commissioned to the Japan Fine Ceramics Center (JFCC) and the Japan Fine Ceramics Association (JFCA) from the New Energy and Industrial Technology Development Organization (NEDO). The JFCA will conduct research studies, and the JFCC will do the actual development work. As the coordinator of the research cooperation, the JFCC has formed contracts with companies and research organizations. The companies are Sumitomo Electric Industries, Ltd.; Asahi Glass Co., Ltd.; Kyocera Corp.; Ishikawajima-Harima Heavy Industries Co., Ltd.; NGK Insulators, Ltd.; JGC Corp.; Kubota, Ltd.; NEC Corp.; INAX Corp.; and Noritake Co., Ltd.

That which will be critical in the selective separation of CO_2 is the development of the ceramic film. From the results of the feasibility study, three types of separation mechanisms are hypothesized: 1) only CO_2 passes through fine holes because of the differences in molecular diameters; 2) a basic process takes place on the surface of the film, and the CO_2 is separated because of chemical adsorption and dispersion effects; 3) CO_2 is absorbed in ion form, and a molten carbonate that can release it in its original form supports the film.

Ceramic films are used in vessels of distilled water, but a molecular-level film has not yet been made practical. Although there are polymer films used for molecular-level separation, they cannot be used to separate CO_2 from a steel mill's hot exhaust gas, the temperature of which ranges from 300°C to 900°C. For that reason the decision was made to use a ceramic film. MITI will also establish evaluation technology and modularization technology at the same time.

Utilizing the high temperature of the CO_2 that is separated and recovered from exhaust gas, the system will make the CO_2 react with methane in a high-efficiency reduction device to convert it to CO and hydrogen. The hydrogen will be used directly as energy, and the CO will be converted into substances such as formic acid and calcium carbonate. Along with developing this technology, MITI will also search for other effective utilization methods.

Advisory Committee for Energy Advises Measures to Stabilize Coal Supply

94FE0817E Tokyo NIHON KOGYO SHIMBUN in Japanese 17 Jun 94 p 2

[Text]

In Pursuit of Better Combustion Efficiency for Supply Stability in the Asia-Pacific Region

Coal Subcommittee's Interim Report Calls for the Transfer of Desulfurization Technology and Other International Cooperation Efforts

The Advisory Committee for Energy (headed by H. Yamazawa) compiled a report that cites the need for international cooperation in dealing with the problems associated with the use of coal—global warming and acid rain—in order to ensure the stability of coal supply and demand in the Asia-Pacific region. The report proposes promoting the development of technology for improving the efficiency of coal combustion, providing aid to developing countries by transferring desulfurization technology overseas, and Japanese-led formulation of coal supply-and-demand forecasts for the Asia-Pacific region.

Establishment of an "International Market Issues Forum" Also Proposed

The report first notes the importance of coal as an indispensable petroleum-alternative energy that is economical and whose supply and demand is stable. Despite the new energy-conservation measures adopted in Japan, domestic coal demand is expected to expand from 116 million tons in FY1992 to 130 million tons in FY2000 and to 134 million tons in FY2010. The report points to the need for dealing with the environmental problems associated with coal combustion and the need for supply-and-demand stability in the Asia-Pacific region.

As a concrete measure, the Advisory Committee for Energy proposed the "Technology Development Action Program for More Efficient Energy Utilization." The program would be a government policy for development of technology that increases the efficiency of coal combustion for the purpose of holding down the amount of CO_2 generated. In that the committee calls for the establishment of 1) pressurized fluid-bed boiler (PFBC) power-generation technology, 2) integrated gasified coal cycle (IGCC) power-generation technology, 3) melt reduction steelmaking technology, and 4) fluid-bed cement calcination technology. The committee also points out the need for the development of hydrogen-production technology that uses coal and the need for research to elucidate the mechanisms of coal combustion.

As an acid rain counter-measure, the report outlines a plan entitled "The International Clean Coal Action Program." The plan calls for encouraging China and other coal-producing countries to cooperate in accordance with their level of development. First, the cooperating country would formulate a master plan for utilizing coal in an environmentally correct manner, then model efforts such as the installation of desulfurization equipment would activate the country's awareness of environmental measures. The committee goes on to depict a scheme in which Official Development Assistance (ODA) would be used to urge such countries to make self-supported efforts at environmental measures and to cooperate in fostering an environmental industry. On the other hand, coal demand in Asian-Pacific countries other than Japan is expected to grow tremendously, which may disturb supply and demand. Already the decision has been made to hold a summit on coal supply and demand, based on the Asia-Pacific Economic Conference (APEC). In addition, the Advisory Committee for Energy proposes that an "International Coal Market Issues Forum" (provisional name) should be instituted as a place where concerned parties from each country can exchange ideas.

AIST Announces FY95 Policy to Research Carbon Cycle in Ocean

94FE0817E Tokyo DENKI SHIMBUN in Japanese 29 Jun 94 p 1

[Text] MITI's Agency of Industrial Science and Technology (AIST) solidified its policy to begin in FY95 the research and development of a global-scale model of the carbon cycle in the oceans. The purpose of the model is to get an accurate understanding of how CO_2 emissions affect global warming. From data gathered in research studies carried out since FY92 to study the mechanisms of the carbon cycle in the ocean, AIST has been developing a three-dimensional general circulation model of the North Pacific Ocean and a "one-dimensional vertical model of ecological system carbonate chemistry," which takes into consideration biological activity down to the middle layers of the North Pacific Ocean. Starting next fiscal year, however, AIST will focus on the development of a global-scale model; in a five-year-long project the agency will tackle the development of a "general circulation model" that will take into account global-scale biological activity. AIST's completion of that model could contribute significantly to reliability in predicting climate fluctuations.

The amount of carbon that humans now discharge into the atmosphere is said to be 6 billion tons per year. However, the amount of increased carbon in the atmosphere is only about half of that, and the "missing sink" for the rest of the carbon becomes a cause of unreliability in forecasts of future climate fluctuations. The oceans, which contain about 60 percent of the amount of carbon in the atmosphere, are seen as one missing-sink destination, but very little is understood about that mechanism.

For that reason, since FY92 AIST has been surveying the ocean and air along the longitudinal line 175°E, from 45°N to 15°S. The agency also used the data to develop the three-dimensional general circulation model and the one-dimensional vertical ecological system model.

With the three-dimensional model, researchers estimate that about 20 billion tons of human-generated carbon was absorbed by the North Pacific Ocean during the 2,000 years prior to 1986.

Because the research study finished completely this fiscal year, a small group within the assessment committee of the Industrial Technology Council's Energy and Environmental Technology Development Section conducted a preliminary assessment.

The assessment group said that continuing the observations is necessary. As for AIST's three-dimensional model, although the estimates of CO_2 absorption can be evaluated, the range is limited to the North Pacific, which is insufficient for simulation of the general circulation in the oceans. In addition, the group pointed out that the effects due to biological activity are not incorporated into the model, and that a model that incorporates an ecological model of a broader marine area is needed.

After hearing the assessment, AIST said that in a five-year project starting in FY95 would develop a three-dimensional model of the general circulation in all the oceans of the earth, and that the model will incorporate the effects of biological activity. In order to verify the model, AIST intends to carry out observations for the purposes of getting a better understanding of ocean circulation, secular changes, and seasonal fluctuations; measuring the amount of carbon movement and fixation speed; and understanding the middle layers and depths of the oceans.

Future Form of the New Image Information Industry

94FE0729A Tokyo KIKAI SHINKO in Japanese
May 94 pp 4-24

[Panel discussion with Takemochi Ishii (Chairman, Image Information Industry Subcommittee, Industrial Structure Council, MITI, and Professor, Faculty of Environmental Information, Keio University), Nobuyuki Idei (Executive Director and Head of Creative Communication Division, Sony Corporation), Shigekoto Kaihara (Professor, Faculty of Medicine, University of Tokyo and Chairman, Central Medical Information Department, University of Tokyo Hospital), Seiichi Sato (Executive Director, Dai Nippon Printing Co., Ltd., and Director of ACS Operations Division), Michitaka Hirose (Assistant Professor, Department of Machinery and Information Engineering, Faculty of Engineering, University of Tokyo) and moderator Hideo Morimoto (Assistant Director, New Image Industries Office, Machinery and Information Industries Bureau, MITI)]

[Text]

Images and the Information-Age Society

Morimoto (Moderator): I want to start by thanking you all for attending today. I know you are very busy. My name is Morimoto, and I will be your moderator.

On 16 March this year a report was issued by the New Image Information Industry Forum that was chaired by Professor Ishii. The report painted a bright future for the new image information industry and also discussed creating an environment for supporting new industries. Moreover, the government decided to budget more than ¥10 billion in information-related projects for New Social Capital through the FY93 supplemental budget.

Today, I would like to begin by discussing the report from the New Image Information Industry Forum and asking each of you to contribute your thoughts on this topic. Let's begin with Professor Ishii.

Ishii: First, I have been asked to begin by describing the background of the technological revolution and the spread of image information. This information is also included in the summary of the report. If we take memory capacity as an example, the very first information-related technologies were at best kilobit technologies, and performing calculations was the center of attention. When IC integration increased to megabit levels, the focus became text characters, symbols, and sentences. In the very near future we will have gigabit technology. This will make image processing possible, and we can expect it to consume an extremely large amount of data.

Of course, we need a complete system that not only performs information processing but also has a means for transferring information in and out, such as transmission capability. The quality has improved tremendously in other fields such as optical fibers, satellite communications, and video cameras, (especially in the case of camcorders and 8mm videotapes). They are now quite affordable and have become widespread. As you well know, color TV is widespread not only in Japan but throughout the rest of Asia as well. In Japan we have spent nearly half a century with TV in our lives, and of course it has had a tremendous impact. Current technological progress is characterized by the fact that, first of all, products have become less expensive and more available to the general public as a result of making them smaller (what we call downsizing). Next, in terms of social structure, they affect society as a whole, just like a road affects automobiles.

More specifically, in the case of images, which is what we are discussing today, they began as motion pictures in the mechanical age, or let us say the mechanical-chemical age, and those images represent the level of technology in that age. Essentially, we had a social system based on the theater. Eventually, motion pictures moved into the home, and many people who are now in their sixties remember that as young adults they themselves took 8mm home movies of their own children. Now the home movie camera has been completely replaced by the home video camera. Moving pictures and images with audio have been developed for a multitude of uses ranging from simulations for academic study to activities in our daily life at home. When I was a graduate student, the output of computers was numerical data at best, but now people expect the output to be images that they can see. For example, in the case of dynamic numerical relationships such as those in a wind tunnel, visual experiments performed on computers have now become the mainstream, and now it appears that research without such visualizations has almost become extinct. So, things have changed quite a bit since the motion picture age, and virtual reality, which seems to be the ultimate extension of this trend, has rapidly attracted a lot of interest.

If we think about it for a minute, virtual reality has not been around for 10 years yet, probably not even five years. During that time, however, things have been changing so fast that "virtual reality" has become a common expression. The basis for this, of course, is social change, and many things have been strongly affected because the change is so rapid. In the case of images, changes in the social milieu are headed toward making transmitted messages fast, easy to understand, scientific, international in the sense that they transcend language, and pan-generational in the sense that they transcend age. The simplest examples are in fields that in the past have been considered minor such as games, "karaoke," and so on. Despite the recession, these markets have shown rapid growth and actually, the profit ratio is so high that software for these items has become a business on its own.

Of course, the same kinds of phenomena have occurred in the printed media, and Japan has become a cartoon superpower, exporting cartoons rather than conventional text material all over the world. In a sense we could say that printing technology has switched over to images as well. Or we could also say that the fax machine has converted the telephone to an image. Today we cannot even conceive of a telephone network without fax machines. Instead, everything today is based on fax machines from regular business transactions to publishing. So even though we are discussing this single concept of images, recently we have begun to enter a new era. The instant we enter the gigabit age, all present kinds of information will become second-level information. We have some confusion right now because if we take the concepts that we have held since the first level of information was the megabit at best and erroneously refer to that as the information-age society, then conversely, those concepts will hinder progress. In the case of corporations, for example, the structures of companies formed during the age of mainframes is entirely different from those that utilize distributed, downsized equipment.

Things are also very different in different countries. With respect to information in developing countries, I often use the expression "leapfrogging," because the most sophisticated, inexpensive items become available from the start. If we take telephones, for example, when you say the word "telephone," especially in the newly industrializing economies in Asia, it means a portable telephone, which has become a necessity. On the other hand, a telephone with a line is considered a luxury, because it takes a lot of money to lay telephone lines. Japan is the other way around. Here, a normal telephone has a line, and a portable telephone is a luxury. Our values are exactly reversed. My generation experienced the transition from the age of radio to the age of television, whereas children who are born today start out with television as an everyday item. In the same way, the circumstances of different countries are entirely different.

For example, radio waves that are broadcast via satellites spill over and can easily be seen in neighboring countries. When that happens, the majority of images are readily understandable (although the language may not be), and aspirations and demand for new fashions and consumer items rise rapidly. Star TV satellite broadcasts from Hong Kong cover a huge broadcasting territory, and in terms of broadcasting territory alone, this is the largest empire since Genghis Khan. It affects the basic motivations of people in society.

If we narrow our discussion to changes that are due to handling information at two levels, the first level is the kind of change typified by NC machining as an example of the way information handling affects the machinery industry and so on. NC is an abbreviation for numerical control. Just as the letters indicate, the N stands for numerical values. Control is achieved through numerical values. This concept has expanded into a type of factory automation, or what we might call the CAD/CAM stage, and when we reach the CAD stage, we are talking about images. Initially, the drawings were wire frames, but now the second level of information is on the verge of transforming itself into a new mechanics based on NC that is called mechatronics. Beyond CAD, the machinery industry will utilize multimedia or networks. Networks are integrated industrial manufacturing systems that cover a very wide territory such as CIM (computer-integrated manufacturing). Right now, the most advanced tests concern remote machining while the operator looks at an image. Experimentally, this is performed using satellite communications between, for example, an American university and the University of Tokyo.

When this transition occurs, the parts of the machinery industry dealing with images and the parts dealing with satellite communications will be combined, and the general impression is that these two parts will fit together like a nut and a bolt. In a manufacturing plant that kind of expectation comes naturally. Even when the networks link different factories, people will gradually begin to feel they are present in the same place, just like virtual reality, and joint operations will begin to assume a new form. From now on, I believe the changes in industrial structure and the effects of second-level information will be considerable.

Idei: Professor Ishii just mentioned the "gigabit age." Basically, it seems that we are experiencing an explosion in digital technology right now. Processors are becoming faster and faster, and memory is getting cheaper and cheaper. With the advance of digitization and using information on the gigabit order, we will be able to deal with images on the computer. At Sony we can record and play back 1 gigabit images with quality approaching broadcast quality in about six minutes. Previous computers and personal computers were not good at handling images and audio, but at the gigabit order we can actually aim for tapeless image handling, and the result is likely to show up directly in our business.

One example is the production system editing machines for broadcasting. At this year's NAB show for broadcasters, there were about 20 companies marketing computerized editing machines for broadcasting. This means that the lines between the AV makers like Matsushita and Sony and the computer makers have all but disappeared, and I have a feeling that we are on the verge of a "big bang" in the industrial world. So I think we can say the biggest change taking place today is the fact that we are very close to digital technology and in fact, we are beginning to use it. Because digitization is so near in so many fields in the industrial structure, I feel very strongly that the time has come for people in fields like AV, computers, publishing, motion pictures, communications, telephones and so on should get together and discuss things whether they like it or not.

We often hear the term "strategic alliance" tossed about, and in this case I think these alliances are a natural result of the way things are unfolding. In the past individual companies could get by using their own formats, but recently strategic alliances have become very important. As a result, many companies have been bought and sold, and many new affiliations have been formed.

Sony made purchases in 1987 to form Sony Music and in 1989 to form Sony Pictures. Just as Professor Ishii said, if a broadcasting company like Star TV in Hong Kong is very powerful in terms of distribution, then for the motion picture industry it can create a business that brings in a lot of revenue. Therefore, companies have found it necessary to respond to the changing world in a global manner. When we consider the spillover from satellites, this is a real business opportunity because rather than a wasted signal, it represents a chance to shoot for worldwide coverage.

Another topic to consider is why TVs and computer monitors are entirely different items. Don't you think it is very strange that a household must have two monitors, one for the TV and one for the computer? That kind of question naturally comes up. In the past we considered it normal to use NTSC for TV images, and we did not envision using the 680x480 dot computer monitors as televisions.

When we go one step farther and think about where high definition will fit in, we find that in the past Japan has proceeded under the concepts of the image industry, while the U.S. has proceeded under the concepts of the computer industry. That is because in the U.S. the AV industry is almost non-existent, but they have a big semiconductor industry. I believe that we have a situation in which companies from both countries will form more and more alliances to complement their weaknesses. I expect the need will become stronger and stronger in the private sector for discussions between Japan and the U.S. concerning, for example, a cooperative structure for creating this new image information business. I think the need will become stronger and stronger to hold discussions at the governmental level as well.

Moderator: Mr. Idei just mentioned combining computers and TV. In the U.S. there are very few color TV makers that can supply the hardware, but the number of places making computers has proliferated greatly. This seems to be a major trend in the U.S., but computers and TVs have still not been combined, have they?

Idei: You're right. Basically, today's TVs that use NTSC do not display text characters well at all. We must write text characters very large because small characters flutter on the screen. Essentially, today's TV displays are not really suited for reading text. In that sense, computer displays are more advanced. Still, the revenue from display sales has increased considerably, and at Sony the ratio is roughly 10 to 3, with color TV revenues representing the 10 and computer displays, the 3. This depends somewhat on the makeup of the company and the scale of its manufacturing, however, so at other places these figures may be the opposite. When we consider household terminals, for example, if people start wanting to read their newspapers on TV, we will have to come up with a system to meet those changing needs.

Increasing Range of Image Utilization

Kaihara: I would like to change directions a little bit and discuss things from the standpoint of those who use images, the consumers.

To us, gigabit-level images are an earth-shattering development, but there is a problem if we have images alone. The images become significant only if they can be linked to communications and transferred.

The world of medicine is a very greedy world in the sense that if we find something we can make use of, we try to employ it in as many ways as possible. The desire to utilize images has been around for a long time and in a sense, the starting point for therapeutic medicine is an image. In ancient times famous doctors could make an accurate diagnosis just by observing a patient sitting there silently. That is what we are told, at least, and they made their diagnosis by looking at an image, so therapy is impossible without an image. When a doctor says he wants to take a look inside your belly, what he really wants is to see that image.

So doctors desperately seek to see images, and we have tools like X-rays, CT, and MRI to create images of things that cannot readily be seen. These form one level of images, but now doctors are saying: "I want to be able to see them from far away."

You see, one of the characteristics of modern medicine is that a doctor cannot do anything independently in isolation. Therapy can finally begin when there are specialists and nurses available nearby to help out. However, it is not always possible to achieve this kind of therapeutic environment. If that is the case, doctors still want to make use of specialists in therapy, even if they are physically far away. As I mentioned earlier, images are the starting point for therapy, and when it comes to consulting with a doctor who is far away, we must transfer those images to have the specialist look at them. Medicine has developed to that point, and we have very strong needs to transfer images.

However, we still cannot send moving pictures, so the practice of taking long amounts of time to send still pictures over conventional telephone lines has become very widespread in the real world. For example, it is very difficult to transport a patient to the Aomori Prefectural Hospital when it is buried in snow. When patients absolutely must be transported, then that is what we will do, but in many situations the patient's condition does not require transport, and in those situations we want to be able to say: "Your condition is not that serious, so you

don't need to come to the hospital." For that we definitely must have images. Still, the 500x500 still pictures that are currently sent by telephone are much better than nothing, and in Aomori Prefecture there are now about 10 hospitals linked in a network. That is how important images are to us.

Moderator: Is the network running all the time?

Kaihara: It runs all the time. There is such a strong need that we had to have somewhat better images, so we actually installed HDTV. After that we have heard nothing but rave reviews.

Therefore, doctors would like to have that kind of capability as soon as possible. Right now in the medical world our biggest problem is the lack of a communications infrastructure. That is the bottleneck holding things up. On the one hand, the image industry is making progress and its equipment is improving. If the communications infrastructure does not proceed at the same pace, however, the image industry will not spread into other areas, at least if we take medicine as an example. Right now, that is my honest impression. That is my first point.

Recently, however, some people want to take things a step further, and there is a rather widespread desire to "bring images into the home." In a sense this will mean sending the specialist to the patient's home, and it will be sort of like a house call via images. When we think about it, from a technical standpoint it is the same kind of thing I was talking about before. The problem is the same—we lack an infrastructure. If we build an infrastructure and install the equipment in homes, the need will be there from the start, and my understanding is that doctors are already working on a structure for this. I believe we are almost there, but still a step away because of the infrastructure problem. Once the infrastructure is completed, we can expect the current form of therapeutic medicine to change entirely. Right now patients crowd into large hospitals and wait for hours. Of course, there are some people who ought to be there, but a large percentage could get by without making the trip to the hospital. If we had remote therapy capability, it would revolutionize the world of medicine.

I believe current technology has the potential for these kinds of developments. People like me are always saying, "We have to start thinking now about how we are going to treat our patients when that day comes." I definitely do not think this is just an idle dream. I believe that within the next 10 years it will become a practical issue that must be addressed.

One other point is the recent discussion about sending educational material (knowledge) to far away places, which have stirred up a great deal of interest. In the past we only had databases, so educational material was stored at a single location, and if we wanted to transfer educational materials, we could only send text. Recently, however, we have heard promising stories about the merging of multimedia and telecommunications. If this can be combined with image communications, I believe it will open up a whole new world.

Recently, people have come to use the Internet without a second thought. What is mind-boggling when you use the Internet is the realization that information from all over the world is available instantly at your fingertips. Moreover, the Internet uses multimedia with moving images and audio. Recently, when I was on the Internet I found an image on the screen that looked like an advertisement for a night club. I was wondering why in the world this image was on the screen, so I selected it. First an attractive photo of people dancing appeared and then an explanation of the night's agenda. The Internet is essentially for research purposes, and I didn't expect to find that kind of thing. I was wondering if something was wrong until I realized that it was a night club in Mountain View, which is right next door to Stanford, and the computer science people at Stanford had posted a message that their meeting that evening would be held at the night club. So actually it was not a night club ad, but a meeting announcement. My point is that this type of information can actually be seen by anyone in the whole world. That is the age we are living in.

After that experience I became convinced that in the future the method of dealing with educational material will surely change. Actually, there is a system called Mosaic, and people are working hard to compile textbooks on it right now.

But these textbooks are very different from conventional textbooks. When you click a button on these textbooks, you get audio and a large picture, and sometimes a moving picture. Moreover, although the textbook is created in one place, it can be used all over the world. What will education be like in the future? There will be no need for universities and university teachers. Everyone will race to create a textbook at a single location. Telling the students to study the textbook may make education much more effective than telling them go to lectures and so on. The new age of images may bring about a revolution in education as well. At least, that is the impression I have.

I have been talking about medicine and education, but something that will be very important when we go to do those things is the software. Creating that kind of a textbook is really a monumental task, and a good text cannot be created unless many different people bring together the most up-to-date knowledge. If that is the case, we must train specialists to create the software and its contents. Therefore, multimedia linked with digital images and communications offers great potential, I believe, but to realize multimedia we must do more to develop the communications capability, the software, and other items associated with it. That is what I think.

Moderator: Thank you for your comments.

I would like to expand our discussion a little. We often hear about Internet or Mosaic. Even if people like myself

want to get on the Internet, we cannot obtain an address, but university professors all have their addresses printed on their business cards. What do you think about that, Professor Kaihara?

Kaihara: Well, I've had one for a long time.

Moderator: What about you, Mr. Sato?

Sato: Things are beginning to improve.

Moderator: I see. If that is the case, then there must be a large number of users.

Idei: There are about 30 million worldwide.

Kaihara: Although it is not often the case, when it comes to the Internet Japan is way behind everyone else. Even so, those in the private sector have recently gained sufficient access...

Sato: At Dai Nippon Printing we have an environment in which people with technical backgrounds can use the Internet rather easily, but people with humanities backgrounds have a much harder time. The truth is that within the same company we have two very different cultures. So I think Internet use must vary quite a bit from company to company.

Moderator: So the people in research labs and so forth are the ones using the Internet.

Sato: That's right. I wish the company would organize the environment to make the Internet easier to use. It could start at the individual level and bring things together later on. There are many ways it could be done. I think there are many places that are eagerly waiting to use the Internet.

On the other hand, graduates are finally emerging from the Shonan-Fujisawa Campus (SFC) of Keio University, where Professor Ishii teaches, and I have heard that companies now are actively seeking out students that are used to using the Internet. It sounds reasonable to me.

Idei: Now E-mail addresses are common on business cards.

Sato: That's right. People are beginning to put them on their business cards.

Idei: Yes, and so if you want to get in touch with me, I can give you our company's phone number, and now it's becoming a matter of which net a person is on.

Hirose: And there are professors in foreign countries who only read their E-mail, so the fastest way to get an answer is to ask a question by E-mail. In other words, it's the most effective way to get in touch. Don't you think that E-mail will become more and more widespread, based mainly on university campuses?

Idei: Yes, I do. Recently, there was a conference on the Information Super Highway at UCLA, and we were told that for information on the conference to be held in May we should access the Internet. When the host asked for people in the audience who use the Internet to raise their hands, a large number of hands went up.

Moderator: When you go online to Mosaic, do you find that it already has some moving pictures?

Kaihara: There are those that last about five minutes. But you cannot see them online. You have to download them once before you can view them. That takes a little bit of time.

Moderator: I understand that there is difficulty with the tools involved in creating that kind of software. The color of the characters on the screen is different, and when you click it, the contents appear like with hypertext. I have heard that creating this kind of structure is very difficult with conventional authoring tools.

Kaihara: Right now there are not very many, and the ones that do exist are in the public domain.

Hirose: I guess we are still in a situation in which capable people create the tools on their own. Doing it by themselves in their own way is probably more convenient than creating something just for the pleasure of hearing other people say, "Hey, this is easy to use." They delight in the fact that open information software is much easier to use. This is not a complete consumer approach; rather it is more of a prosumer [note: combination of production and consumer, cf. *The Third Wave* by Alvin Toffler] approach.

Idei: So, right now only a very limited number of people can use these tools, and this gives them a certain amount of status. I think they should make these tools so anyone can use them.

Ishii: This will become a problem when the scale of the industry expands. People talk about computer literacy, and in any event, we must do a lot to train students to use computers while they are in school as a fundamental part of society. If people are using computers just for leisure purposes, there is no need to hurry, but if business and academia depend on the full-fledged practical use of computers, then universal computer literacy becomes a real issue. We should do this the same way we increased the literacy rate of the populace when Japan began to industrialize during the Meiji Restoration. Even if the hardware became available in the form of railway trains, there would have been only a limited number of passengers if people could not read the names of the stations and the information on signs. A high literacy rate is essential to industrialization. I think the same kind of thing is happening now. Japan has fallen behind in the full-scale education of her people in information literacy. Some people wonder whether games should be as popular and as widespread as they are, and games is a market that does not require literacy. The Internet is different; you have to be literate. Even if you have access to a whole library, if you have not received a formal education and do not have a dictionary, you cannot study. I

have a feeling that recently we have encountered a similar kind of hurdle with information.

Moderator: I agree.

Right now, information-related government offices are using the Internet quite a bit, but in Japan the Macintosh is the only personal computer that can use the Internet. The personal computers installed in other government offices do not have the capability. The communications software is weak, some people hog the equipment, and some offices have no modem. Things are so bad that no one uses the Internet. (laughter)

Ishii: But if the people there are not computer literate, it doesn't make any difference anyway. (laughter)

Moderator: When I say the situation is dismal, what I mean is that no one has time to read the E-mail. We have to form the habit of looking at the E-mail at least once a day, morning, evening or even at night, and being diligent about answering it. If we do not, the stacks of paper in the office grow higher and higher, it becomes difficult to associate with people in the office as friends, and we begin to wonder how we can ever go on.

Idei: So you have to create your own personal communication system, and if you do not, there is no way to process all the information. If the computers we use at the office and the ones we use at home are completely different, and there is no link between them, then we stop using them altogether. I think it is time for a complete restructuring.

Hirose: This ties in with what Mr. Idei just said, but in a sense E-mail still belongs to the information elite; it is a kind of tool for afficionados. The trouble is that these afficionados do not understand what the general populace needs. Basically, there are a lot of young researchers who have time on their hands, and they are the ones who created the E-mail system. Earlier Mr. Morimoto said that there is no time to read E-mail, and E-mail for busy people has yet to be invented. For example, when I go overseas I use E-mail to keep in touch with Japan. Sometimes it takes as long as two hours to read my mail. I spend two hours out of a 24-hour day reading E-mail. Even for me, that is overkill. If the E-mail culture becomes more widespread in the future, we will have to create E-mail for busy people, E-mail for company presidents and so on.

Moderator: I see. That will probably involve images.

Hirose: I expect so. We can comprehend images at a glance.

Ishii: Although it may be a little fuzzy, rapid macro-comprehension is desirable. For example, we can utilize the continuous deformation of images to show that there is a relation between item A and item B without saying anything. A kind of psychological construct is formed just by looking at those images.

Moderator: They become linked in the mind.

Ishii: That's right. But if we try to express that concept carefully in E-mail sentences, it will get very long. I think the present situation is like Hinayana Buddhism. A person might finally understand a difficult sutra after reading it through over and over. This kind of activity is not for the general public. We are now in an age like one based on an elite, specialized priesthood of Hinayana Buddhists who leave their homes, suffer many deprivations, and shut themselves up in temples in order to understand the sutras. When we move in the direction of Mahayana Buddhism, in which everyone can attain Buddhahood by simply staying at home and reading the Sutra of Wisdom [note: Prajna-paramita-sutra], images will be our tools, and they will assume a significance similar to that of the Sutra of Wisdom in Mahayana Buddhism.

Kaihara: If we look at this from a slightly different angle, I think the biggest problem in the world of the Internet and E-mail is authorization, in other words, putting an official seal on something. This technology is fine for personal communication, but if a government office, for example, has to issue a message as an official document, it becomes a problem.

Recently I was talking with a person from the Ministry of Foreign Affairs, and I was surprised to find out that people who work there cannot arbitrarily send faxes. To send a fax they must always obtain permission and give it an official number. In effect, all their faxes are treated like public documents.

Idei: I don't know about that, but they do practice encoding. They put things in code. There are many different levels. The worst ones we have to deal with look completely black at first glance. They are written in black on brown paper. They are impossible to copy. We have received some documents with that special kind of printout. We have part-time secretaries rewrite them by hand and make copies of them. Well, that is the world they live in. Still, as you said, this delays information.

Kaihara: Government officials living overseas send faxes from their homes. They say that if they send it from home nobody complains.

Ishii: Even if that happens only within Japan and everything gets delayed, there is a kind of order to it. What causes a lot of problems for corporations right now is the fact that Japan's system is a very slow-moving system. If companies plan to work together with foreign corporations in the kind of strategic alliances we just discussed, they will find the foreign partner moves much more quickly. Essentially, the tempos do not match. In that case, what happens? The relationship breaks down because the foreign company interprets the delays unfavorably saying that the Japanese are just stringing them along and actually plotting to leave them hanging, or saying the Japanese are not sincere. In the future we have to match our pace to theirs.

Hirose: Although it is supposed to be a very confidential matter, using E-mail for the peer-review process for

ac demic journal articles has increased. If we think about this for a second, it is a rather dangerous practice. If a mistake in the address is made, the document will be sent to someone entirely unrelated to the business at hand. The fact is that E-mail is easy to use, and although it has its drawbacks, I think it will come to be used more and more. I think we will find this gradually accepted in more and more areas in the future. In the case of items like public documents, it will bring about a host of problems, I expect.

Idei: Recently, there was protected intellectual property worth something like $250,000 or $1,000,000 released over the Internet.

Sato: So the holder was damaged...

Idei: Yes, and the culprit was fined.

Sato: There have also been cases in which items that were originally intended for sale have been openly released over the Internet.

As a result, I think that it is necessary to change our previous approach toward information. As was mentioned earlier, each person addresses the items himself and sends them, so he must take responsibility for what happens to them. In the past, if a letter was wrongly delivered we could blame it on the postal service, but with E-mail we have to assume all the responsibility. If we do not realize that E-mail brings with it both convenience and responsibility, I believe we will be unable to cope with this new age. In that respect, when the general populace actually begins to use it, I believe we will have a problem gaining a consensus on this issue, or knowing to what extent these agreements are understood.

Moderator: In the magazine *Wired* there was an article entitled "E-mail: Spoken Language Written Down," and I think that is true. I suspect, however, what has become E-mail is really information that would have been conveyed orally in the past rather than in an official form.

Hirose: Therefore, it is extremely important to have many channels for information. A large earthquake occurred in San Francisco when I was studying in the U.S., and the first thing that went down was E-mail. After that, telephones and fax services recovered the fastest, although they were somewhat unreliable. In the case of E-mail, whenever there is trouble at a particular node, everything piles up there.

So I think it is better to send extremely important information by fax or even send it by regular mail, because its intended use is different.

What 'Image' Means

Moderator: We have talked a lot about E-mail, but what about images? (laughter)

Professor Hirose, please relate your experience.

Hirose: I would like to talk about virtual reality. At the beginning of the 1980s, if a person suggested displaying TV images on a computer monitor, he would probably have been called a fool. Both computers and TVs used a CRT, but one was for displaying text and the other for displaying images, so people considered them entirely different. Recently, however, multimedia computers have appeared one after the other, and people think nothing of it. Especially in the case of virtual reality, if someone asks if it is image technology, the answer will be "yes," and if someone else asks if it is computer technology, the answer will also be "yes." In the future, this kind of chimeric technology will appear more and more often, and I think the gap between TV images and computers will gradually be filled in.

Earlier we were discussing "gigabits," and I have heard that the computing speed of computers is doubling every year. That means in 10 years it will increase about 1,000 times. If we look into this carefully, we find that not only computing speed, but memory capacity, communications speed and many other items will really be 1,000 times greater than today. If we look at history, there has never been a machine like this before. Engineering departments generally make calculations to the second significant figure, so 0.1 is usually treated as a zero. What I mean is that if this kind of thing is turned upside down, there will be no end to it, and in 10 years computers will be machines with an entirely different nature. At least, I think that is what we should anticipate. Images and other kinds of technology will make their appearance under these circumstances.

This is a little off the subject, but I have a feeling that we most likely belong to the generation of researchers that will be sitting right on the fence during this changeover. For example, when Professor Ishii was writing his thesis for his bachelor's degree, a thesis had to be written in text, but now research themes are newer, and it is no longer adequate to describe issues like creating images or making them move merely in text. In our day, it broke our young hearts because we laboriously wrote out our bachelor's theses only to hear comments like, "Well, here's another student with a weird thesis." We belong to a generation resentful of the slings and arrows we suffered from archaic evaluation standards. I have heard that students at Professor Ishii's school are producing their bachelor's theses on VCR, and to me this means that ways of thinking have changed quite a bit.

As its name implies, a computer is a machine that does computation, but actually only a small part of modern computers is devoted to computation. Most likely the computing capability makes up less than 10 percent of the total. If we ask what the remaining 90 percent is doing, it is involved in conveying the results of the computation in a form easy for humans to understand, or it is drawing pictures with computer graphics and so on. In the past these functions were considered trivial. I myself used to say, "Images are toys for women and children; real men don't fool around with them." Of

course, now I feel completely different. I think images are important, not only in the sense that they show us results in an attractive manner, but also because they are dynamically entering our thought processes.

In the past we often wrote out whatever we were planning in sentences. We used a word processor to write out the sentences. At first everyone thought a word processor was some kind of printing machine. We considered it a machine that would take a completed handwritten draft and turn it into clean printed copy. We came to realize, however, that was not the case, that the true nature of the word processor was to use it to create sentences right from the start. Then people appeared who organize their thoughts as they are creating sentences and typing them out on the word processor. Now we do that too. I think the same kind of thing is happening in the field of images as well. We have this concept that images are only something we use in a final presentation. However, what will happen in the future is that people will use images to think, what we can call a kind of "visual thinking." Essentially, in the past we have thought in text, but from now on we will think in pictures. I believe that time is approaching.

This way of using images will not be merely to make computational results attractive. In the past, people in many different fields have handed over their results to an image specialist to create the images for them. With visual thinking, however, I believe that images will become more important than ever before because in our own thinking processes the images will be inserted a are writing out the rough draft. I have a feeling th development will trigger a huge market.

If we ask why we could not accomplish this with previous image technology, it is because the past image technology is not interactive. For example, using a motion picture means merely viewing a film that is already finished, so if someone said, "I don't like the way that idea is expressed; change it," it would mean taking it back to the motion picture company right away. However, images like virtual reality that employ modern technology are manipulated by the user, and they respond accordingly. What this means is that people themselves will be creating the images, and they will have a two-way relationship with images rather than merely looking at the images that have been created by some image specialist. In that sense, something slightly different from traditional image technology has begun to emerge in the form of multimedia and virtual reality. As I just mentioned, because images will be incorporated more and more into our thought processes, we are facing an entirely new set of circumstances.

As I mentioned at the beginning, I believe that the new world of images that is upon us cannot be adequately explained in terms of computers alone nor in terms of images alone. There is still a gap between them. In the 1980s, it was truly a deep chasm that could not be crossed, and although it has become shallower, the gap is still there. It is true that computers can create pictures and that TV broadcasts can be shown on multimedia personal computers and the like, but there is still a considerable difference in quality, and basically they leave a lot to be desired. I think that it will be important to fill this gap skillfully. I think we have to think carefully about how to combine computers and images neatly and smoothly.

As Professor Kaihara mentioned before, software will play an important role in this process. Because computer people are technical people, they will work very hard to create a framework. More specifically, however, they are surprisingly ignorant of what to express. If we take TV as an example, technical people work very hard to make receivers, but have no interest at all in the creation of the programs that appear on them. If we look at a modern TV station, we can easily see how nonsensical this kind of attitude is. Image people, on the other hand, tend to be artistic, so they are interested in exactly the opposite. What we really need right now are people who have one foot in each area. Right now this is becoming a major issue. Image specialists can create interesting products to a certain extent, but they do not know much about computers, so we cannot expect any revolutionary improvements. On the other hand, if we use only programmers, we cannot guarantee the quality of the content. I think that from now on it will be extremely important for us to train people who know both fields.

Moderator: When it comes to human resources in the future, we have strong doubts about the training of personnel as well. No doubt, we need those kinds of people, but what about a market in which they can display their talents. I think it becomes kind of a chicken and egg problem, and if there are more and more places for people to display these talents, then people will enter those fields. I have a feeling that in their work they will be dealing with images while doing other things.

Hirose: Of course, you are correct. No matter what kind of talented people are available, if there are no jobs for them, there is no point in pursuing that kind of career. So as I said before, we must create a new market that includes things like visual thinking. In a sense, we may be talking about a kind of generation gap. There are still not many people who were brought up in the TV era. When people make presentations, they still believe that the written word carries a lot of weight. When presentations through images and pictures become more widespread, the market will expand considerably.

Now when we hear the term "computer graphics," we have this image of "Title Back" [phonetic] used in TV broadcasts or the huge computer graphics production costing several million yen that is planned to appear on SIG GRAPH. However, if we would ask to have our presentation materials for today's conferences created on a Macintosh, for example, there would be a rather large demand for image services, I believe. As Professor Ishii mentioned earlier, if machining plants and other places

would take images already available and use them as a new form of machine control, that would also be part of the image business. I think images will come to be used in fields where they are not used at all today.

As the TV generation continues to grow, we will find that more and more people employ visual thinking, so I feel rather optimistic about market expansion.

Idei: Up till now computers have been oriented toward the productivity of organizations; the fact that IBM stands for International Business Machine pretty much says it all. Apple is a little more culturally oriented, but on computers aimed for productivity, the applications most often used are word processors and spreadsheets. Basically, on the other hand, we AV makers have always been involved in entertaining people rather than productivity. However, computer makers have pretty much reached their limit, even in the U.S., with word processors and Lotus 123, and business is not expanding much.

I think we have reached a period in which human resources will be shifted rapidly to entertainment; to a world where people can enjoy themselves considerably. Unfortunately, I think that the U.S. has leaped out ahead of Japan and that the changes will come very fast over the next five years or so.

Ishii: As you say, it is clear that Japan is far behind in the majority of areas. One reason is that when we go about creating a market, we emphasize the side of the suppliers too much. However, as you pointed out, items that suppliers create to satisfy themselves are usually not interesting at all. In other words, Edison invented the phonograph, but Edison did not create best-selling records. The ones who did were people from opera or from show business. The fields of fine arts or amusement have poor connections with the computer business.

Idei: And that is why Japanese hardware makers kept repeating the same thing over and over until they reached the top of the mountain, and now they're going down the other side into recession. (laughter)

Ishii: That is a fundamental problem. Before we were talking about visual thinking. There are a lot of people who believe that it wouldn't hurt merely to do some thinking, visual or otherwise. There are limitations, however. Let's say we have a complex number. If we use logic, we don't need to visualize it. There is no need, for example, to use a Gaussian plane. However, if someone says, "Think of all complex numbers without using a Gaussian plane," it is almost impossible to do. Even Gauss, the great genius himself, would have had trouble without using visual thinking. On the other hand, when someone mentions a complex number, we develop the concept as points on the Gaussian plane. So if we think about this carefully, although it may be merely a tool, a rather fundamental mathematical system was created from it, and it could not have been created without it. At the beginning visual thinking was considered something like a carnival sideshow with a very minor role in the scheme of things, but there's an outside chance that it may be much more serious. It may be another Gaussian plane.

Moreover, the quality of the media, how good the image is, for example, can vary considerably depending on the level of interest in the contents. What I mean is people have a very strong interest in themselves and their loved ones even if the quality of the image is very poor. So the content cannot be separated from the form. The content, in other words the scenario or story contained in the software, is inherently linked to picture quality. To say it another way, if there is almost no content, like the mindless demos that the makers have put out, then just as in the case of Edison's samples, there will be no market unless the picture quality is improved dramatically. But if the content is interesting, then the picture quality can be much lower. Or recently, people like Steven Spielburg have been intentionally reducing the picture quality to the home video level in important scenes to enhance their sense of realness. That makes them look more natural.

Idei: *Schindler's List* was shot in black and white.

Ishii: That's right, he shot it in black and white. Viewers have become wise to staged events on TV, and they realize that if things weren't planned out ahead of time, they would not come out so neatly. In that sense, they've lost their sense of realness. So "virtual reality" is a very paradoxical phrase with a lot of deep implications. By their very nature, human beings are narcissistic; they are strongly interested in themselves and events related to themselves. Therefore, things concerning people should be based more on the content than the screen quality. The problems we have had with educating the general populace and so on are a result, for example, of a kind of dualistic approach such as the one that separates the mind and the body. Here again, as we have heard in the past, the true meaning of a new media becomes a deep philosophical problem, especially with respect to what one writes and for what purpose it is written. When a new media is involved, the answers to these questions change considerably.

Everything so far has proceeded in a structure in which things are written, mostly on paper, using printing technology, and that has formed our sense of values. The occupation of "author," for example, did not exist before printing. People did not make copies by hand. But as soon as printing was developed, the author and his work became completely separated. The work took on a life of its own, and it was controlled by treating it as an "object" and determining who owned it. But now what is written is no longer an "object," so the issue becomes what kind of new social rules this development will create. For a while there will be a period in which past rules and past methods can be modified and applied, but I think things will change even more in the future.

This is a little off the subject, but I think people of different generations are truly different if there is about

40 years between them. Just about 40 years ago in the mid 1950s, computer input and output was very simplistic. The TAC computer that I first used read input off a paper tape (laughter). The output, of course, was a printer but the printer was just a typewriter. It was called "a genius with a weak body." It could perform processing quickly, but the input and output, the arms and legs of the creature, were terribly weak. About 10 years passed, and in the middle of the 1960s we got the CRT. I saw two of the first CRT displays. One was at MIT and the other was at NPL in London, England. This is slightly different from what we were talking about before, but the first thing I felt was that the computer's output was not from a printer but on a TV. Therefore, my own psychological interpretation of all this is that, essentially, the starting point was TV. Therefore, I see nothing at all strange about returning to TV, but somehow it seems that TV and computers have become completely isolated from each other.

Hirose: Actually, the 1960s were a very exciting period in computer science. Even the basic ideas for things like virtual reality were already floating around in the 1960s. At that time, however, computers were still not very capable, so people set aside those ideas like the most delicious part of a meal, and planned to enjoy them later, but 10 years passed and they forgot about them completely. Just as you said, the concept of television and the concept of the computer have become completely separated. Finally, in the latter half of the 1980s, technology started to catch up, and the two concepts began to move toward each other once more. If we look at history, we find that people come up with the same kinds of ideas many times over the years.

Idei: Even though we use the term "computer," up till now a computer has basically been a stand-alone box. A TV is also a box, and until now we did not have the technology to hook the two together completely. I think that today's computer manufacturers are still stuck on the concept of a stand-alone item. I wonder what the people who make computers will do in the future.

For example, let's say we have a person who makes computers and a person who makes Sony TVs. If we ask how they are different, I suspect that both of them are actually struggling with the same kinds of problems involved in making boxes. The people who make TVs think, "All we ever do is make TVs." People who make audio CD players think, "I wonder how long this will continue," and when we look at computers and say, "I wonder how long computers can go on without changing," I think they are all basically saying the same thing.

For example, if images can be readily transferred in a network environment, the hardware will change, and most likely a lot of new businesses such as home shopping or information-on-demand will appear. When that happens, if the general populace cannot use the Internet, or if there are no advantages to using it, then new businesses that are accessible to everyone will emerge, and I think our society will be very exciting. I believe no other period in time will offer such business opportunities.

Hirose: To the general populace computers and TVs probably look the same. Rather, it is the specialists who make the distinctions.

Idei: That's right. They look the same to people who don't know the difference.

Hirose: They do look the same. That is why we have to eliminate the boundaries between the specialists. I suspect these next few years will be critical.

It is important for computer and TV specialists to get to know each other. I'm ashamed to admit this, but I used to think that a TV and a computer monitor were the same. Now I understand that their contrast is entirely different. If we show a computer image on an HDTV-like monitor, it will look alive. People will say, "That's fantastic." I'm sure that until now computer people never used words like "expression" or "presentation," but people who work with images use them quite a bit.

Idei: In the past computers were rather limited in terms of color data, and generally they could display about 25 colors. Their performance has improved tremendously, though, and now they can display as many as 32,000 colors.

Ishii: Remember, this all started with a paper tape. (laughter)

Idei: On the other hand, TVs have very few limitations in terms of color. That is one difference.

Hirose: So I think it is really exciting that the two sides have started talking, and if they are doing research in virtual reality, they come up with brand new ideas every day.

Ishii: When graphics first came out a computer specialist at a certain university said, "We have no need for images." As a result, a large number of students got the short end of the stick.

Moderator: The same kind of thing has happened in government. Now when we discuss budgets they tell us to include at least one picture. But they used to get angry when people included pictures.

Ishii: They used to tell you to write things down properly, didn't they?

Moderator: Yes.

Ishii: That's rather hard to believe, but once we had a very promising student. Essentially, he had done remote collaborations and joint projects with images. Although he didn't have to print it all out, he was told, "All you have to submit is a CRT character list. We don't need the images." They made him a very unhappy student at that time, but now they probably would give him a medal. (laughter)

Future of Image Industry

Moderator: I would like to discuss printing a little bit, especially since we mentioned colors.

Sato: Actually, I am speaking from the standpoint of an industry that has struggled with this, but I believe that the information industry is undergoing major changes. So far we have discussed things from many different angles, and it is difficult to predict how things will change but no doubt, the changes will be great. I believe people engaged in the information industry are really groping to find the direction they should take in the future.

If we look at the historical process, we in the printing business have dealt with these kinds of new media from rather early on. Actually, the history of the process of photolithography roughly matches that of computers. Using computers with Japanese characters came into practice about 20 years ago. Looking back at it now, we used computers with less performance than today's personal computers, and we first started using them to check whether the text characters would fit within a certain framework or not. When computer performance improved later on, it became possible to incorporate and modify color images through digitized data processing. Because of that historical background, there was a relatively smooth transition to electronic printing based on character images on a CD-ROM and creating high-definition still pictures called "High Vision Graphics" with software. People outside the company may get the impression that we have skipped over a lot, but insiders know that we are working on new media within this milieu of computerization and digitization from many different angles.

I am saying this partly in jest, but when we think about the digitized, multimedia age of the future, all kinds of companies will become customers for the printing business. In fact, everyone will be our customer, and they may even become our competitor (laughter). I think this will be a sticking point in the so-called information-age society or new age of images. I think all of us are involved in a kind of friendly rivalry to bring about the age of multimedia.

However, when we look at the long history of printing, the relationship between people and paper stretches back 4,500 years, since the invention of papyrus, and printing has been around for 500 years. On the other hand, if we think about it the relationship between people and displays has existed less than 50 years, as Professor Ishii pointed out. If you look at books for a very long time, for example, you may feel a little tired, but they are very easy on the eyes. However, I wonder about the interaction between displays and the human eye. Will human beings change, or will displays become different? I think this kind of affinity problem is one of the issues that is still unresolved.

One other thing, I think that there is still a lot of room for improvement in the world of basic books. We often hear people say that we won't be using paper anymore, but I say that we can intentionally work to make books better, and if we do so the paper media will surely survive. If we use more high-tech methods, we may see the day in which we not only read books, but they speak to us. I believe that books still have considerable potential, and that includes these kinds of new techniques.

I am certain that if we make the effort, books will survive well into the 21st century as an important media among the diverse media of the future.

In this past series of hearings by the New Image Committee, our company's president introduced the concept of the "information park." This has been discussed before, but if we ask why printing has been around for such a long time, I think one major reason is that anyone can become a writer, so in essence, everyone can participate. I'm sorry to say this but I have a strong feeling that only experts will be able to create the software when we arrive at the image society. I hope that the information-age society comes in a form that makes it easy for people to join in. As Professor Ishii mentioned, everyone has switched from 8mm film to video, and their surroundings tell them that images are something they capture by themselves. People do not need to have polished image productions, even partly finished productions will be fine. Let them bring their productions to the image park, and people can help each other create a piece of software. Even if it is only partly finished, we can show it to other people. The images do not have to be so beautiful. We can have grandmothers telling their grandchildren about the old days and parents saying, "Oh look! There's grandmama." The concept for the image park is one of an image forum where people can easily gather together to create new information as they join each other in the park and use their own productions as raw material.

I believe that the concept behind MITI's Information Center captures part of this approach. It need not be a place where special people such as artists gather. If people have a feeling that they have information they want to convey to other people, they can easily gather there and make use of the facilities while they watch. That is the kind of environment we would like to see. If that does come about, we will see a situation in which people will change their concepts about personal and intellectual property so that everyone can use information. Now we have very accomplished people, each with their respective rights, and sometimes they bump heads. I think that we may have to divide our treatment of information, handling it easily in one sense and handling it carefully in another. If a new way of dealing with intellectual property does not naturally evolve from this environment, the laws imposed unilaterally by the government may be very difficult to enforce in a new era. Because of this kind of problem, we proposed the information park.

Hirose: One point of confusion concerning how the general populace can get involved with images involves

editing, I believe. Good motor skills are needed to splice tapes skillfully. Recently, however, advances in digitization have made it surprisingly simple. This is one area of information that computer specialists do not know about, and many must be instructed by people who work with images. They say, "What? Is it that easy to do?" They are running as fast as they can to catch up. When these new kinds of machines appear, it will be possible to create productions that are quite entertaining without specialized editing skills.

Ishii: After observing students at Keio University, I think that editing requires artistic talent. For example, if there is a student who likes dance and is a good dancer, the dance videos made by that student will really be good.

Idei: I see. It's because the student really understands dancing.

Ishii: That's right. The visual quality of the images themselves may not always be that good. However, the student produces it herself. One note about what we were discussing before, the concept that many kinds of people can easily participate, is that a person does not necessarily have to appear in his own production if the production is about something the person likes. If that is the case, people who like a certain subject will understand that production much better than one made by image professionals who do not know much about the subject but can capture very beautiful images. In that respect, the issue of amateurs is a very interesting one. Of course, they must have a good means to create these productions, so as soon as these digital editing machines become available, it will become an issue.

Idei: They will not need something as impressive sounding as a digital editing machine. It will be simple if the performance of home computers increases just a little more.

Hirose: Recently, we experienced a revolution in personal computers, and I believe that images are on the verge of becoming something personal.

Kaihara: I would like to see a dedicated industry for creating multimedia software at the same time. The reason is that in the medical world we have a mountain of videos. I think that about half of them will be more valuable for the future if they are converted right now from videos to multimedia educational materials. I think they would last a lot longer and have greater significance. But even if I wanted to ask someone to do that, I have no idea who I should ask. Right now, no one is available to do this, and I think it is a real shame. I suppose it could be done at Mr. Idei's company or at Mr. Sato's, but ordinary people would not be able to comprehend the images. We all thought that Mr. Sato's company only did printing (laughter), and that Mr. Idei's company only produced hardware, so naturally we assumed companies that make videos are motion picture companies.

Idei: I think the time has come for that kind of centralization, for example, the idea that all movies are made in Hollywood, to break down. So in that sense, I know that printing technology, for example, is difficult (laughter), and when I went to the Mac World Expo at Makuhari this year, it looked to me like more than half the exhibits were printer shows.

Sato: I thought the same thing.

Idei: So in that sense, there were so many beautiful images printed out. Printers for home use have made such startling progress that I wonder how much farther they can go.

Sato: In terms of the general level of demand, I think they have already reached a satisfactory level. With the exception of bookbinding, it is simple to print small numbers of self-published materials now. And if we add the output of a good color printer, people can produce beautiful books.

Idei: That's right. I was thinking it was time for things like newspapers to be printed at home. (laughter)

Ishii: Essentially, if there are no more delivery people, that is what will happen.

Idei: Rather than running those huge presses and then delivering the product, right?

Hirose: That is because of what Professor Kaihara said before. First it must become widespread at the bottom. Isn't it true there is a top because the bottom spreads out and pushes it up?

Amateur comic readers are really something. When we print comics as a single bound book, there are some people who tell us that the lines in the first printing are very clean but in the third printing the lines look muddy and so on. So when we reach the point where everyone is looking at interactive images day after day, they will become more critical. Professor Kaihara said that good multimedia is still not available, but that is only natural because the foundation has not become broad enough. And what is available has not yet been weeded out. Conversely, when the foundation becomes very broad, the champions that emerge are really wonderful.

Sato: With respect to that, right now CD-ROM software is being sold in the U.S. in supermarkets for $9.90 apiece. People approach it with the same attitude as buying an audio CD, and regardless of the quality of the contents, an impressive number of CD-ROMs is in circulation. So just as Professor Hirose said a minute ago, we need to create a foundation from which good-quality software will emerge.

Kaihara: You have all heard of the very famous hospital called the Mayo Clinic. The Mayo Clinic itself is making CD-ROMs and selling them to patients. These are CD-ROMs for interactive patient education. I don't know which came first, the chicken or the egg, but if there is an industry available to make those kinds of items, I believe

someone will come up with a way to make and sell them. Conversely, when these items become widely available, they will begin to show up in people's homes, and people will want to buy their own and read them.

Hirose: From what we have seen with games so far, that is probably what will happen. The first games were so primitive that they make us laugh when we see them now. Games were placed on the market indiscriminately, and the business was developed by repeated trial and error to find out which ones were good and which ones were terrible. This process produced great progress and excellent software. I think we have to cherish this kind of process.

Ishii: I'd like to make another point. Right now when we speak about images, we often mean images without audio, but synchronization with audio is essential. At school they have separate times for drawing, language arts, and music classes. It will be no good if we put together a curriculum using multimedia and still keep separate academic subjects (laughter). We have to combine images with sound and audio, which becomes very different, especially with the three-dimensional aspects of virtual reality.

Hirose: It is different, isn't it?

In talking about education in the future, people who like pictures generally do not like music. People who like music usually are not good at drawing. We have to find a happy medium between the two. The best solution is to combine them both in the same person. Of course, some people argue that it is better to form teams instead.

Sato: Not only that, when we look at elective courses in high school, students must choose between taking visual arts or music. (laughter)

Moderator: They should be able to take both.

Sato: That's right.

If we look at another aspect of this, right now manufacturers are getting ready to make video CDs. They are hoping video CDs will become a major trigger toward the age of multimedia in the minds of the general populace. Essentially, they are supposed to take the place of videotapes, and people will be able to look at the CD pictures on their TVs at home and select the pictures they want to see. So they will not just be looking at whatever comes through the TV, they will be able to select the programs that they like. This is a little different from multimedia, but people will be able to skip ahead to the parts they want to see rather than the current method of using fast forward to search for the desired place. In other words, this will introduce some PC-like elements into the world of television. Therefore, the users will probably feel that it is somehow different from TV in the past. I'm sure there will be people who want to know how people will be able to use video CDs when they still can't program their VCRs, but I think they will be accepted as something slightly different. I have a feeling that this will provide an opportunity to speed up somewhat the fusion between TVs and computers that we were talking about before.

Ishii: Actually, it is the kind of difference between a scroll and a book. When we look at history, a very long time passed before the jump was made from scrolls to books. It took a long time before information was compiled and bound into books. So with the CDs you are talking about people who will have direct access instantly. Up till now they have been looking at scrolls, slowly unwinding scrolls of pictures like this. So I have a feeling that the kind of changes that occurred with the advent of printing and books are about to happen once again with the advent of multimedia.

Sato: That's right.

Idei: Basically, a video CD is something that is 12 inches across and holds pictures, but it took 10 years to create. Its predecessor was the CD-I, or interactive CD, and actually I was the person who began that work at Sony, but we expected computers to make faster progress than they have, to improve their interactive performance. At that time we had only still pictures. At the same time, the Americans developed compression technology, and suddenly the pictures on personal computers could move. It caused quite a stir. So we made the CD-I into a full motion video. Because it is highly interactive, the hardware is expensive and right now it will not sell. So we decided to reduce the interactive performance so it will sell to the general public, and make the pictures very beautiful, even if they are not very interactive. The problem was that when we showed it to people in Hollywood, they told us that one disk would not hold a whole movie.

Sato: It has only 74 minutes of playing time.

Idei: So we had to use two disks, and the price went up. Now we are hearing demands to raise the level of image information to that same level. We will probably have to wait for the next generation of disks before we can get the kind of picture quality and several hours of playing time that will satisfy people from Hollywood, the cable TV industry and multimedia. I think when that kind of product comes out, things will really get interesting.

Moderator: We have discussed many interesting ideas and there is so much more we would like to discuss, but we have run out of time. Thank you all so much for taking time out of your busy schedules to join us today. I hope we can all meet together in the future and continue our discussion.

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